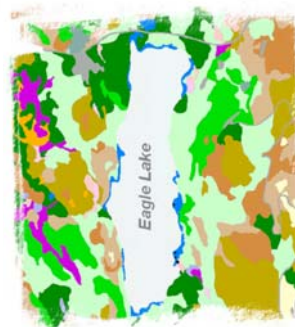# U.S. Geological Survey-National Park Service Vegetation Mapping Program Acadia National Park, Maine

Project Report

Revised Edition – October 2003

U.S. Geological Survey-National Park Service
Vegetation Mapping Program
Acadia National Park, Maine

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and

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by

Sara Lubinski, Kevin Hop, and Susan Gawler

Summary

The U.S. Geological Survey (USGS) is cooperating with the Inventory and Monitoring Program of the National Park Service (NPS) to classify, describe, and map vegetation for over 270 national park units. The USGS Upper Midwest Environmental Sciences Center (UMESC) in La Crosse, Wisconsin, The Nature Conservancy (TNC), and the NatureServe Eastern Regional Office, along with the Maine Natural Areas Program (MNAP), have completed mapping and classifying the existing vegetation in Acadia National Park (NP) and environs. The UMESC provided overall project coordination and compiled all project reports and data for distribution. The UMESC also organized the acquisition of aerial photographs; produced all digital spatial map coverages, including the interpretation of the aerial photographs and subsequent digital map automation; performed the accuracy assessment analysis of the vegetation map coverage; and prepared final project metadata and documentation discussing methods and results. TNC, NatureServe, and the MNAP provided ecological and vegetation support, vegetation field sampling (plot sampling and accuracy assessment), field data entry, and vegetation classification development (including association descriptions) based on the National Vegetation Classification System (NVCS). The USGS Center for Biological Informatics provided oversight to the project. Staff at Acadia NP contributed their botanical and ecological guidance, shared their management and research goals, and provided equipment support, housing, boat transportation, and personnel to help with field work.

The Federal Geographic Data Committee (FGDC) Vegetation Subcommittee has adopted the NVCS as the Federal standard for vegetation classification (FGDC 1997). The NVCS is used for describing the vegetation types and is the basis for mapping within the USGS-NPS Vegetation Mapping Program (VMP). It is an a priori classification that is continental in scope, and was chosen at the beginning of the program to ensure a balance between the needs of mapping local vegetation patterns within each park with the overall need to have consistency between parks. NatureServe and the Network of Natural Heritage Programs manage the NVCS, a system that emphasizes natural and existing vegetation.

Acadia NP was selected as one of several pilot parks to develop and refine the methodology and standards for the USGS-NPS Vegetation Mapping Program. The three basic components of this project are vegetation classification, vegetation mapping, and map accuracy assessment. Classifying and mapping the vegetation proceeded simultaneously as directed by the VMP, hoping to shorten the overall duration of

the project. Accuracy assessment followed classifying and mapping, and gives indication the shortcomings to classifying and mapping in a parallel method.

In Acadia NP, as in other national parks mapped for the VMP, extensive field sampling was conducted to understand the local expression of vegetation types of the park. Samples from 179 vegetation sampling plots were collected during 1997–99 field seasons throughout the project area and subsequently analyzed with previously collected plot data. Fifty-three natural/semi-natural vegetation communities (associations of the NVCS) are recognized and described in detail in this report.

The 53 vegetation communities are represented with 33 map classes. Fifty-eight map classes, including land use/land cover and park specific categories, were used to map Acadia NP and environs. Color infrared aerial photographs, collected in late May 1997 at a scale 1:15,840, were used for photointerpretation. Spring photography was chosen so fieldwork and mapping could begin that same year. Using spring photography limited the ability to map some NVCS vegetation types accurately. Photointerpretation data were manually transferred to orthophoto quadrangle maps (1:12,000-scale) and then digitally automated for use in geographic information systems (GIS).

The VMP standard for map accuracy of vegetation themes is 80%. Field data for accuracy assessment of the vegetation map were collected during the 1999 field season using a stratified random design based on map classes. Overall thematic map accuracy of the Acadia NP vegetation map is 80%; however, some individual map classes fell below the 80% accuracy requirement. Several factors contributed to low accuracy, of which the most critical were (1) map classes were developed before we had an understanding of corresponding vegetation types, resulting in confusing relations between the map classes and the vegetation associations; (2) not enough time in the field with the ecologists; (3) spring photography limited our ability to discern some vegetation types from others; and (4) Acadia NP abounds with compositionally heterogeneous communities with broad ecotones, and would be difficult to map regardless of the process. We provide several recommendations addressing these problems in the hope that future projects may proceed with greater efficiency and accuracy.

Products developed for the Acadia NP VMP include the following:

- This final project report, which includes methods, descriptions of vegetation types, vegetation key, map accuracy assessment results and contingency table, and map class description and visual guide
- Spatial database coverages of the vegetation map, observation points, vegetation field plots, accuracy assessment sites, flight line index, and other supportive GIS data
- Digital data files and hard copy data sheets of fieldwork including observation points, vegetation field plots, and accuracy assessment sites
- Aerial photographs of the project area (one transparency set and two contact print sets) and their corresponding interpreted overlays
- Hard copy flight line index of the project's aerial photographs
- Representative ground photos of each vegetation community
- Graphics of all spatial database coverages, and map composition of the vegetation map
- Federal Geographic Data Committee compliant metadata to National Biological Information Infrastructure standards for all vegetation spatial database coverages and field work data
- CD-ROM containing reports, metadata, keys, classification lists, fieldwork data, spatial data, map composition, graphics, and ground photos

Introduction

Objective of the U.S. Geological Survey-National Park Service
Vegetation Mapping Program

The USGS-NPS Vegetation Mapping Program (VMP) is a cooperative effort by the U.S. Geological Survey (USGS) and the National Park Service (NPS) to classify, describe, and map vegetation communities in more than 270 national park units across the United States. The goal of the VMP is to meet specific information needs identified by the NPS. The VMP, managed by the USGS Center for Biological Informatics in Denver, Colorado, is part of the NPS Inventory and Monitoring Program, a long-term effort to acquire the information needed by park managers in their efforts to maintain ecosystem integrity for all national park units that have a significant natural resource component. Vegetation maps and associated information support a wide variety of resource assessment, park management, and planning needs, and provide a structure for framing and answering critical scientific questions about vegetation communities and their relation to environmental processes across the landscape.

Program scientists have developed procedures to use existing data and to collect new data for classification, mapping, and accuracy assessment. Three major components essential to every mapping project are vegetation classification, vegetation mapping, and map accuracy assessment. Ecology and mapping teams work together to share knowledge and data and to resolve issues to carry out the procedures. Program products meet Federal Geographic Data Committee (FGDC) standards for vegetation classification and metadata and national standards for spatial accuracy and data transfer. Standards include a minimum mapping unit of 0.5 hectares (ha) and classification accuracy of 80% for each map class. Spatial data products include aerial photography, map classification, map classification and description key (<http://biology.usgs.gov/npsveg/overview.html>), spatial database of vegetation communities, hardcopy maps of vegetation communities, metadata for spatial databases, and complete accuracy assessment of the vegetation map. Vegetation information includes vegetation classification, dichotomous field key of vegetation classes, formal description of each vegetation class, ground photos of vegetation classes, and field data in database format.

Acadia National Park (NP) was selected as one of several pilot parks to develop and refine the methodology and standards of the Vegetation Mapping Program. Work in Acadia NP began in 1997. The major collaborators in this project have been The Nature Conservancy (TNC), NatureServe Eastern Regional Office ecological staff, Acadia NP Natural Resources staff, Maine Natural Areas Program (MNAP) ecological staff and contractors, and USGS Upper Midwest Environmental Sciences Center (UMESC) national park mapping staff.

The National Vegetation Classification System

The VMP uses the National Vegetation Classification System (NVCS) for mapping all parks. The NVCS was developed and implemented primarily by The Nature Conservancy (TNC) and NatureServe, and the network of Natural Heritage programs over the past 20 years (Grossman et al.1998). Additional support has come from Federal agencies, the Federal Geographic Data Committee (FGDC), and the Ecological Society of America. The NVCS has been adopted as the National Standard by the FGDC for vegetation mapping to ensure consistent classification of vegetation resources across regions. The use of a standardized national vegetation classification system and mapping protocol facilitate effective resource

stewardship by ensuring compatibility and widespread use of the information throughout the NPS as well as by other Federal and state agencies.

The NVCS is a hierarchical system with physiognomic features at the highest levels of the hierarchy and floristic features at the lower levels. The physiognomic units have a broad geographic perspective and the floristic units have local and site-specific perspective (The Nature Conservancy and Environmental Systems Research Institute 1994a; Grossman et al. 1998).

The NVCS includes most existing vegetation, whether natural or cultural, but attention is focused on natural vegetation types. "Natural vegetation," as defined in The Nature Conservancy and Environmental Systems Research Institute (1994a), includes types that "occur spontaneously without regular management, maintenance, or planting and have a strong component of native species". "Cultural" vegetation includes planted/cultivated vegetation types such as orchards, pastures, and vineyards.

The physiognomic-floristic classification includes all upland terrestrial vegetation and all wetland vegetation with rooted vascular plants. The hierarchy has five physiognomic levels and two floristic levels (Table 1). The basic unit of the physiognomic portion of the classification is the "formation", a type defined by dominance of a given growth form in the uppermost stratum and characteristics of the environment (e.g., cold-deciduous alluvial forests). The physiognomic portion of the classification is based upon the United Nations Educational, Scientific, and Cultural Organization (UNESCO) world physiognomic classification of vegetation, which was modified to provide greater consistency at all hierarchical levels and to include additional types (Drake and Faber-Langendoen 1997).

Table 1. National Vegetation Classification System physiognomic-floristic hierarchy for terrestrial vegetation (from Grossman et al. 1998).

Level	Primary Basis For Classification	Example
Class	Growth form and structure of vegetation	Woodland
Subclass	Growth form characteristics (e.g., leaf phenology)	Deciduous woodland
Group	Leaf types, corresponding to climate	Cold-deciduous woodland
Subgroup	Relative human impact (natural/semi-natural or cultural)	Natural/semi-natural
Formation	Additional physiognomic and environmental factors, including hydrology	Temporarily flooded cold-deciduous woodland
Alliance	Dominant/diagnostic species of uppermost or dominant stratum	*Populus deltoides* temporarily flooded woodland alliance
Association	Additional dominant/diagnostic species from any strata	*Populus deltoides* - (*Salix amygdaloides*) / *Salix exigua* woodland

The floristic levels include alliances and associations. The alliance is a physiognomically uniform group of plant associations that share dominant or diagnostic species, usually found in the uppermost strata of the vegetation. For forested types, the alliance is roughly equivalent to the "cover type" of the Society of American Foresters. Alliances also include non-forested types.

The association is the finest level of the NVCS. The association is defined as "a plant community of definite floristic composition, uniform habitat conditions, and uniform physiognomy" (see Flahault and Schroter 1910 in Moravec 1993). Most schools of floristic classification have used this concept.

Ecological Setting of Acadia National Park

Acadia NP, the first national park to be established east of the Mississippi, is on the coast of Maine primarily in Hancock County (with outlying areas in adjacent Knox County) and encompasses almost 48,000 acres of granite-domed mountains, woodlands, lakes and ponds, and ocean shoreline. The park consists of a large portion of Mount Desert Island as well as some adjacent mainland and island tracts. Acadia consists of approximately 35,000 acres in fee (land held by government authority): 30,000 acres on Mount Desert Island, 3,000 acres on Isle au Haut, and 2,000 acres on Schoodic Peninsula (Patterson et al. 1983). Additional lands are held in conservation easements. With 3 million visitors per year, Acadia is one of the most heavily visited national parks (Figures 1 and 2). Lands donated between 1916 and 1929 form the core of the park, and smaller additions are still being made to its landholdings and easements. Mount Desert Island has an almost 300-year history of settlement, including extensive land clearing, and the peninsulas and other islands in Penobscot Bay have been likewise settled or at least used for pasture and/or timber for centuries.
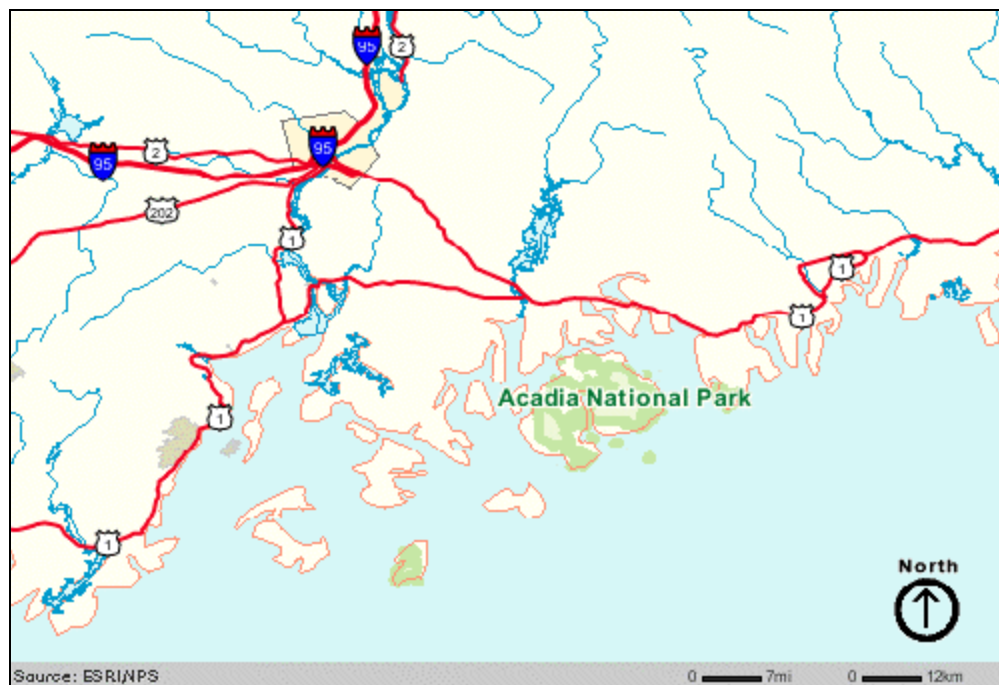
Figure 1. Acadia National Park with major highways marked on the mainland.

The lands within Acadia lie between 44º 12' and 44º 27' N latitude and between 68º 19' and 68º 27' W longitude. The maritime climate is cool and humid and fog is frequent, often lingering along the coast. At Bar Harbor, rain averages about 123 cm (49") annually, and snow about 1.5 m (5'); temperatures can range from -9º C (-16º F) in winter to 41º C (105º F) in summer, with a mean annual temperature (1940-1980) of 8º C (46º F; Patterson et al. 1983). The park lies at the western edge of the East Coastal biophysical region (McMahon 1990), which corresponds to the Maine Eastern Coastal subsection (in the Fundy Coastal and Interior section of the Laurentian Mixed Forest province) of the U.S. Forest Service ecoregion delineation (Keys et al. 1995).
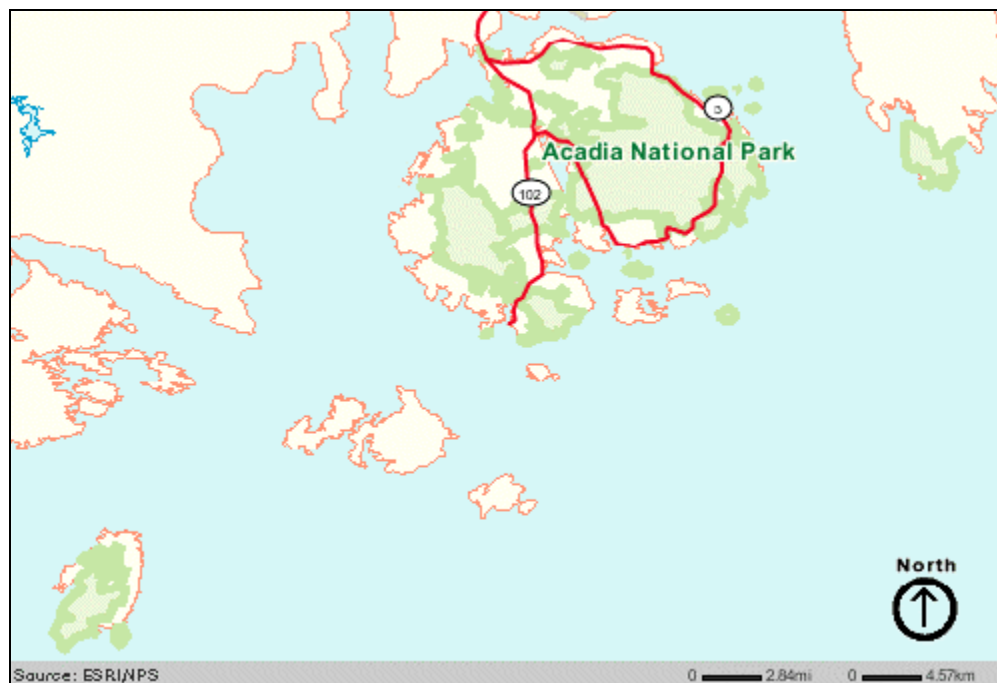
Figure 2. Acadia National Park with access and major roadways marked.

The landforms of Acadia NP are among the best-known features of the park and gave origin to the name Mount Desert Island (roughly, "Isle of the barren hills"). Glacial and post-glacial activity have left a series of north-south trending ridges separated by deep U-shaped valleys. (One of the valleys, Somes Sound, is the only fjord on the east coast of North America.) The ridges are rounded along their crests and extensive areas are treeless, standing out sharply above the predominant forest cover of the region. Areas of the park outside of Mount Desert Island have less rugged relief. Upland soils are mostly thin and granitic, with many areas of bedrock or talus where soil development is minimal at best. Wetlands are underlain by marine deposits or poorly drained tills and include both mineral soil and organic soil wetlands (Calhoun et al. 1994).

Acadia NP lies at the southern edge of Westveld's spruce-fir-northern hardwoods region (Westveld 1956). The vegetation reflects this transitional position with some areas more southern in character —pitch pine (*Pinus rigida*) woodlands, including areas of scrub oak on Acadia Mountain, at their northeastern range limit; or the *Ilex glabra* dominated fen on Isle au Haut reminiscent of Cape Cod and similar coastal plain areas. Other areas exhibit a boreal influence (headlands with *Rhodalia rosea* and *Iris setosa* or rocky woodlands with patchy cover of heaths and black spruce). Much of the undeveloped region is characterized by various expressions of spruce-fir forests or forests in transition toward spruce-fir forests. These have been described by Davis (1966) and Moore and Taylor (1927).

Fire is important to the Acadia NP vegetation. The famed 1947 fire (Figure 3) that burned most of the eastern side of Mount Desert Island is the most recent extensive fire, but evidence of past burns is present in trees and soils throughout the park (Patterson et al. 1983). Thus the present vegetation includes large areas of 50-year-old forest and woodland, as well as areas that have had a longer time since disturbance to develop. At Acadia, early- to mid-successional processes are superimposed on edaphic and topographic factors, all of which must be considered in dividing the vegetation into types and map classes.
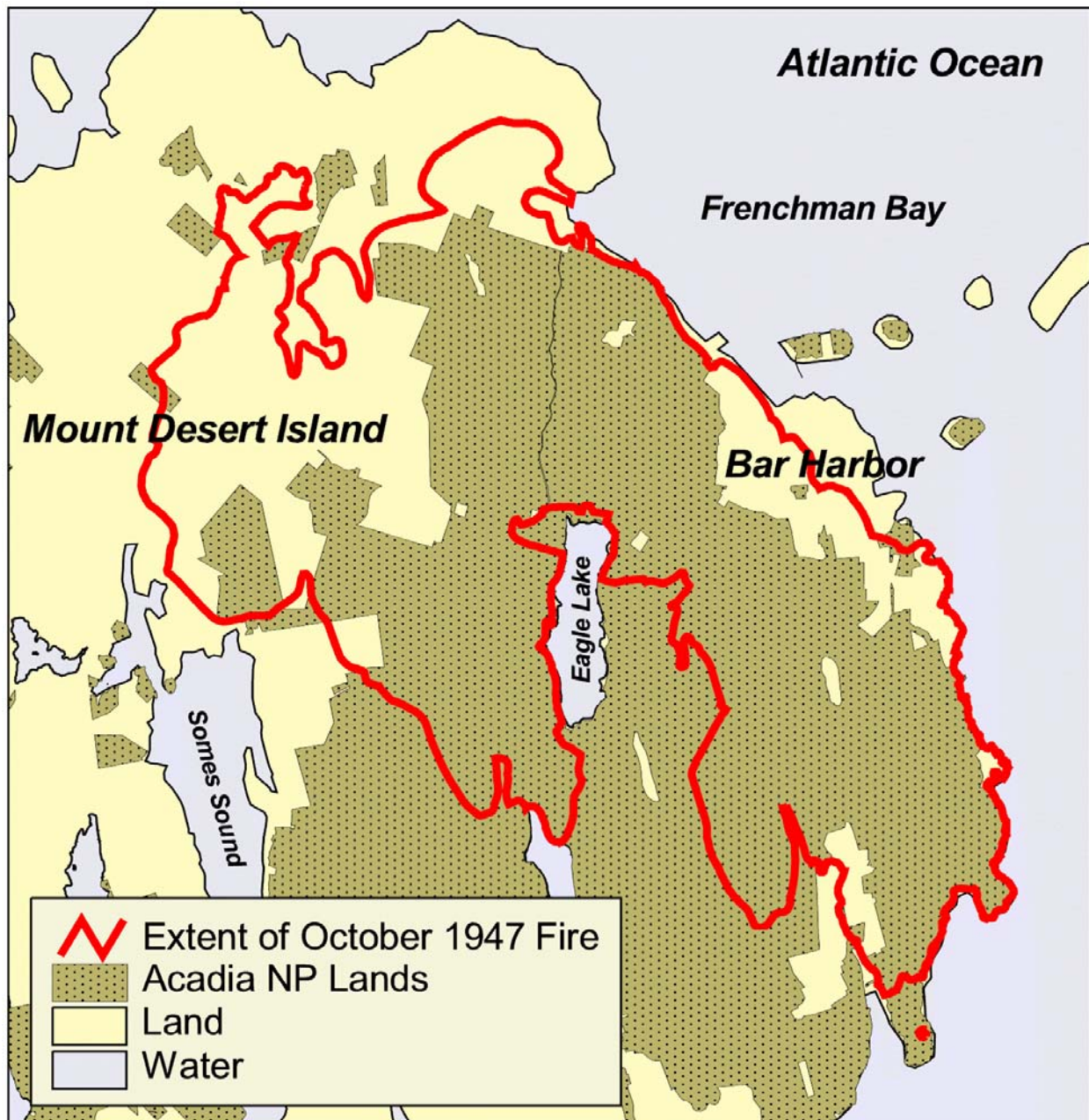
Figure 3. Mount Desert Island showing the extent of the October 1947 fire.

Previous Vegetation Studies

Acadia NP vegetation has long interested phytogeographers and ecologists, with published reports dating back over 100 years. The earliest publications are floras, notably those of Rand and Redfield (1894) and of Hill (1919). Hill (1923) subsequently went beyond the floristic approach to first describe the vegetation of the area, followed by Moore and Taylor's (1927) more extensive descriptions. These early descriptions reflect the prevailing Clementsian view of rather orderly vegetation development to a climax stage.

Kuchler (1956) mapped and described vegetation associations from the southeastern portion of Mount Desert Island (including areas that had burned in 1947) with dominant species and setting given for each. His work was instrumental in the earlier phases of this project, especially in developing the initial list of possible vegetation types for Acadia. Davis's monograph (1966 and references cited therein) on the spruce-fir forests of coastal Maine provides a useful picture of the predominant forests of the region, and remains a classic.

In the 1970s, Waggoner used aerial photos to map the vegetation of Mount Desert Island and developed a vegetation classification. Unfortunately, its utility was hampered by two factors: the emphasis on tree cover to the near exclusion of other layers, and the paucity of ground-truthing (on-site observation to verify and calibrate photointerpretation). Both are understandable, as this was the first attempt at a comprehensive map of the vegetation, and the scope of the task was perhaps not appreciated at the outset.

Recent vegetation work has focused on aspects of the park's flora or vegetation of particular interest. Patterson et al. (1983) spent many years studying fire regimes and fire-related vegetation on Acadia. Calhoun et al. (1994) mapped and described the wetlands of the region, using the U.S. Fish and Wildlife Service wetland classification methodology (Cowardin et al. 1979). Mittelhauser et al. (1996) studied the island flora, fauna, and forest composition. Aquatic plants have been inventoried throughout the park, although without detailed study of how the species are aggregated into vegetation types (Greene et al. 1997). These projects have provided useful compositional or ecological information on particular vegetation types described in this report.

The present report uses these previous works to inform the interpretation of our vegetation sampling, and in some cases, to provide information on types we did not sample. Resources allocated to this project were, however, insufficient to fully integrate the relevant pieces of these previous studies into this report and the type descriptions. Similarly, the geographic information system (GIS) based vegetation mapping presents an enticing opportunity for a more comprehensive analysis of vegetation patterns than in the past, but that was likewise not within the scope of this report.

Participants, Responsibilities, and Meeting Summary

The Acadia NP Vegetation Mapping Project is a cooperative effort among several agencies and organizations. The primary individuals and their roles are

USGS Center for Biological Informatics (CBI)
    Tom Owens - budgeting, program oversight (through December 2001)
    Karl Brown and Susan Stitt - budgeting, program oversight (beginning January 2001)

USGS Upper Midwest Environmental Sciences Center (UMESC)
    Kevin Hop - project management, map classification, quality control, and report writing and metadata
    Sara Lubinski - map classification, photointerpretation, accuracy assessment analysis, report writing
    Janis Boyd and Christine Calogero - digital spatial products

The National Park Service Inventory and Monitoring Program (NPS I&M)
    Mike Story - budgeting, program oversight

Acadia National Park (ACAD)
    David Manski - advisory re park management
    Linda Gregory - botanist
    Karen Anderson - advisory re digital spatial products

The Nature Conservancy, NatureServe and Maine Natural Areas Program (MNAP)
    Jim Drake - project coordination
    Mark Anderson and Lesley Sneddon - NVCS vegetation classification
    Susan Gawler (MNAP) - vegetation sampling strategy, vegetation plots - vegetation data analysis,
    vegetation classification, primary field ecologist for UMESC mapping team
    Jill Weber and Sally Rooney (contractors with MNAP) - vegetation plots and accuracy assessment
    data collection, and field assistants to UMESC mapping team.

The Acadia NP Vegetation Mapping Project formally began in March 1997 when personnel from Acadia
NP, USGS CBI, USGS UMESC, TNC, and MNAP, in a planning (scoping) meeting at Acadia NP
headquarters in Bar Harbor, Maine, organized the mapping project. Specific goals of the meeting were to
review existing data, determine the mapping extent, discuss logistics and protocols, and assign tasks.
Among the topics and tasks discussed were use of existing data, development of the classification and
sampling strategy, data analysis, photointerpretation and digital map automation, determine extent of
photography, and accuracy assessment process. Specific responsibilities and final products were assigned.

UMESC responsibilities and products:
- Facilitate project activities
- Perform field reconnaissance to learn photo signatures and local ecology, and to verify vegetation
  and land use/land cover appearances on the aerial photographs
- Develop map classes that link to the NVCS and other classification systems
- Assist TNC with information regarding the distribution and occurrence of vegetation types within
  the park
- Interpret and delineate vegetation and land use types using aerial photographs
- Transfer and automate interpreted information to produce a digital spatial database (in various
  formats) and hard copy vegetation maps
- Provide a photointerpretation mapping convention report and key
- Produce spatial coverages of all field data collection sites
- Provide accuracy assessment analysis and report results
- Provide a final report describing all aspects of the project
- Document FGDC compliant metadata for all vegetation data
- Provide a CD-ROM containing reports, metadata, keys, classification lists, fieldwork data, spatial
  data, map composition, graphics, and ground photos

TNC responsibilities and products:
- Develop a preliminary and final vegetation classification for the study area based on the NVCS
- Provide guidance to the photo interpreters regarding the ecology and floristic compositions of the
  vegetation types
- Design a sampling strategy to collect vegetation data
- Sample representative stands of the vegetation communities
- Provide vegetation descriptions and keys to vegetation communities

- Field test final classification, descriptions, and keys during accuracy assessment
- Collect accuracy assessment data
- Provide a PLOTS-generated database of vegetation field sample data and accuracy assessment field site data
- Provide documentation on field and analyses methodology and results

During the mapping project, ecologists and mappers held additional meetings and conducted fieldwork to collect the necessary information to classify the vegetation and interpret the aerial photographs. Table 2 summarizes these events.

Table 2. Summary of meetings and fieldwork for the Acadia National Park Vegetation Mapping Project.

Meeting/Field Trip	Locations	Purpose/outcomes	Participants
Scoping Meeting March 25-26, 1997	Acadia National Park Headquarters, Bar Harbor, Maine	Informed the park staff about the Vegetation Mapping Program. Learned about the park's management and science issues and concerns. Learned about existing data. Developed a preliminary schedule with assigned tasks. Started a process to define possible cooperation with neighbors. Defined a project boundary.	K. Anderson, M. Anderson, M. Blaney, T. Curtis, F. D'Erchia, S. Gawler, L. Gregory, K. Hop, D. Jones, D. Manski, T. Owens, N. Shaw, P. Super, G. Waggoner
Gradsect June 9-11, 1997	UMESC	GIS analysis using environmental data layers to determine biophysical diversity on MDI. Results used to plan vegetation sampling.	M. Bower, K. Hop, S. Gawler, L. Gregory, S. Lubinski, T. Owens
Field trip July 29-August 4, 1997	Schoodic Peninsula, Mount Desert Island, Isle au Haut	Confirmed existence of the vegetation types based on provisional community list, correlate the photo signatures with the appropriate vegetation types, and understand photo interpretation limitations. Forty-four vegetation types were visited.	M. Anderson, S. Gawler, L. Gregory, K. Hop, S. Lubinski, S. Rooney, J. Weber
September 1997	Mount Desert Island, Isle au Haut, Schoodic Peninsula	Continued correlation of photo signatures to appropriate vegetation types, verify earlier interpretation	S. Gawler, L. Gregory, K. Hop, S. Lubinski, S. Rooney, J. Weber
Field seasons 1997 and 1998	Acadia NP	Collected vegetation plot data for vegetation classification	S. Rooney, J. Weber
Spring 1998	UMESC	Reviewed and revised map classes to better align with vegetation types	M. Anderson, S. Gawler, K. Hop, S. Lubinski
June 22-July 2, 1998	Mount Desert Island, Bartlett Island	Continued correlation of photo signatures to appropriate vegetation types, verify earlier interpretation	S. Gawler, L. Gregory, S. Lubinski, S. Rooney, J. Weber
Field season 1999	Acadia NP	Finished collection of vegetation plot data and performed an accuracy assessment	S. Rooney, J. Weber

Methods

Aerial Photography Acquisition

Scoping meeting participants agreed to acquire aerial photography during spring 1997 so fieldwork and mapping could get underway the following summer and fall seasons. The UMESC and U.S. Army Corp of Engineers contracted with Aero-Metric, Inc. (Sheboygan, Wisconsin) to fly the photography mission and photos were collected May 27 and 28, 1997 (Figure 4, photo not to scale). An extended area was included in the photo mission to cover possible future easements. The photographs were 9 x 9-inch dia-positive transparencies from color infrared (CIR) film, collected with a 30% side lap (overlap between each flight line) and a 60% forward lap along each flight line to assure full area coverage and stereo viewing capability. Photo acquisition was at 7,920 feet above ground level with a lens focal length of 6 inches to obtain a scale of 1:15,840 (negative scale of 1 inch = 1,320 feet, or 4 inches = 1 mile). We collected 1,179 photos across 28 initial flight lines covering all park fee and easement lands and extended environs. An additional 37 photos were collected (a total of 1,216 photos) across 4 flight lines re-flown over the mountainous areas of Mount Desert Island to adjust the photo scale of the high mountain terrain. Two sets of contact prints were made from the original photo transparency film (one set for field sampling and one for mapping). The photo acquisition was successful in collecting all park fee and easement lands with extended environs (Figure 5). Two hundred thirty-nine aerial photographs were interpreted and used to produce the vegetation spatial database coverage for the Project.

Figure 4. An aerial photograph collected for the Acadia National Park Vegetation Mapping Project.
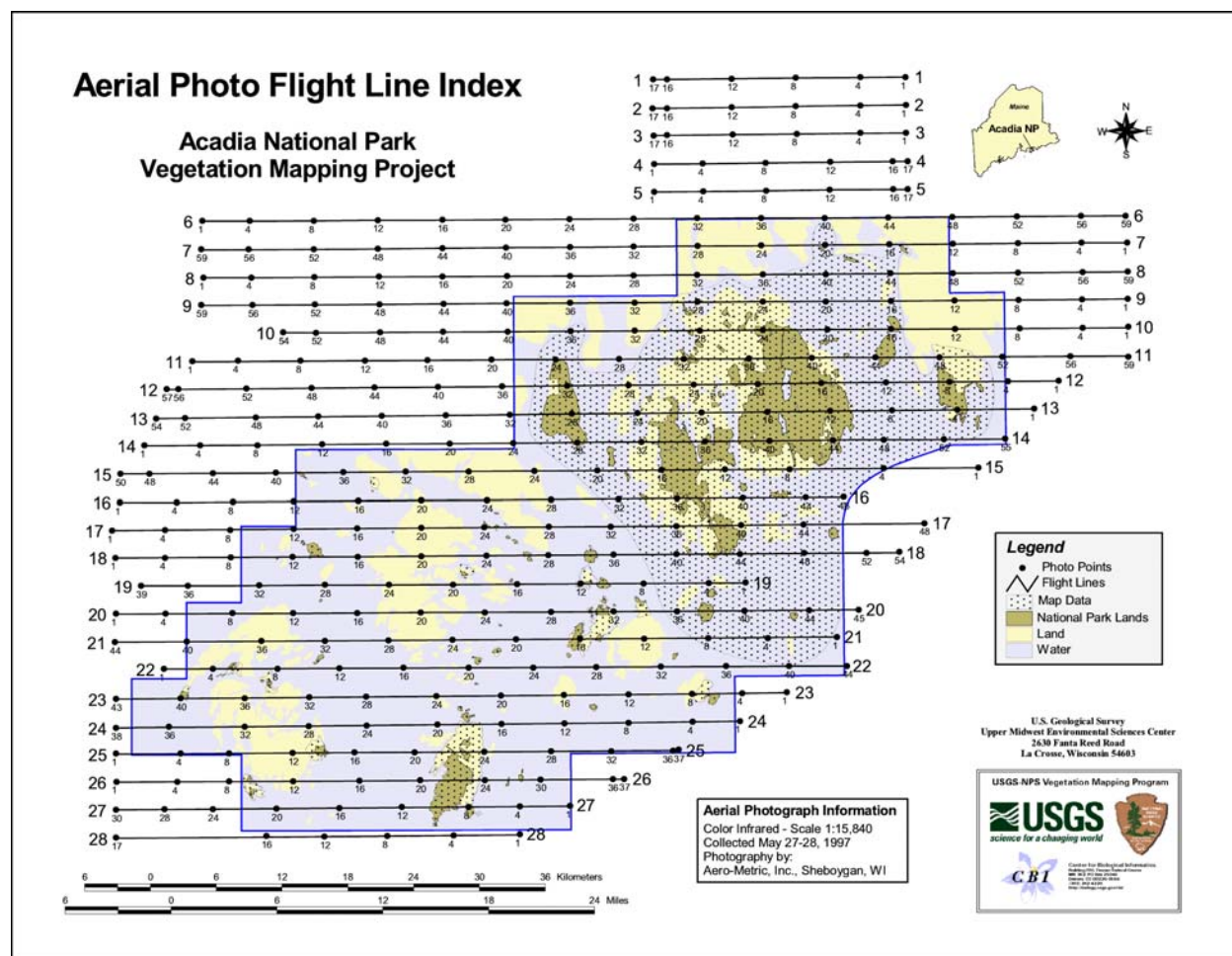
Figure 5. Flight lines flown for aerial photography of Acadia National Park and extended environs.

Fieldwork for Vegetation Classification Development

Vegetation samples were collected for subsequent analysis for defining and describing vegetation communities. Fieldwork planning to develop a strategy for vegetation sampling efforts at Acadia NP consisted of (1) developing a draft list of vegetation community elements for Acadia, (2) conducting a gradsect (gradient directed transect sampling) analysis of Mount Desert Island (MDI) to examine environmental gradients and help focus field efforts, and (3) a field reconnaissance visit (see online glossary of terms <http://biology.usgs.gov/npsveg/glossary.html>). Once a sound strategy was in place, vegetation sampling followed and strategy was adjusted as necessary.

Draft List of Vegetation Community Types

A draft list of 56 vegetation community elements (with cross-references between state and national names) was produced by ecologists from MNAP, TNC, and Acadia NP based on existing community records for MDI available at MNAP, an analysis of the 1956 Kuchler map and descriptions, and additional information and personal knowledge. We used the draft list of vegetation types primarily to grasp and understand the vegetation expressions at Acadia NP, providing a springboard to fieldwork planning and vegetation definitions. We also used environmental, topographic, and geologic information

to develop a list of 23 landforms and cross-referenced each draft type to the landforms with which it was associated. Stratified by two additional factors, coastal-inland and 1947 fire - no fire, this list of landforms provided a conceptual model to which we could compare the results of the gradsect analysis.

Gradient Directed Transect (Gradsect) Sampling Analysis

Gradsect analysis took place at the UMESC on June 9-11, 1997. Gradsect analysis, a GIS technique, uses computerized data layers for a particular area, in our case MDI, to determine areas of greater and lesser biophysical diversity. The basic idea is that areas of higher physical diversity should be areas of higher vegetational diversity, and that focusing limited field time for sampling on these areas increases efficiency when one is trying to sample as many vegetation types as possible.

The utility of the results naturally depends on which variables are chosen. We reviewed the 20 available data layers and settled on five to use as variables (Table 3). We divided each variable into a number of classes. Because of computational and display limitations, we attempted to minimize the number of classes for each variable without losing too much information.

Table 3. Variables used in gradient directed transect sampling analysis.

Fire 1947	Soil Type	Elevation	Slope	Geology
no	not available	0 – 200' (0-60 m): lowland	<25% (0-15°): flat	undefined
yes	muck	201 – 600' (61-182 m): low hills	26-100% (15 – 45°): moderate	beach
	silt loam	601-1000' (183-303 m): medium hills	>100% (>45°): steep	salt marsh
	sandy loam	>1000' (>304 m): higher summits		talus
	very stony sandy loam			freshwater wetland
	loamy sand			exposed bedrock
	fine sandy loam			water
	very stony fine sandy loam			coarse emerged marine sediments
	bouldery complex			fine emerged marine sediments
	outcrop complex			undifferentiated emerged marine sediments
				glacial stream sediments
				end moraine
				till

Each cell of the MDI grid (cell size 70 m) was assessed for each variable, resulting in 224 unique combinations, here called biophysical units (BPU). Focal diversity (F) of each cell was calculated as the number of BPUs within a radius of five cells; values ranged up to 23. Areas of high physical diversity are thus areas with high F values. Two sets of gradsect maps resulted: plotting areas with F ≥10 and plotting areas with F ≥ 15. The 1979 vegetation type was overlaid to generally characterize the areas.

The maps were used with F ≥ 15 to translate the gradsect results into directions for field effort. This selected approximately 20 areas within the MDI portion of the park as areas of high focal diversity. We then used the BPU information accompanying the maps to determine which BPUs were not included within the selected areas, identifying conditions that should be sampled to assure representative coverage. These included saltmarsh; exposed bedrock on medium to high hills; near-coastal areas (emerged marine sediments); talus; and low, flat areas with muck or silt loam soils and without fire.

The areas highlighted by the gradsect analysis did not cover all of the characteristic ecological features of the MDI portion of Acadia. Had we restricted our field efforts to the gradsect-identified areas, we would have missed the bald summits of Acadia that, perhaps more than any other feature, characterize the park; we would have missed important wetlands, including saltmarshes; and we would have missed some interesting near-coastal areas that also support regionally characteristic vegetation. When gradsect is used as a screening tool, it also is essential to determine the conditions not included in the areas selected and adjust the field effort accordingly.

Field Reconnaissance

Reconnaissance in late July and early August 1997 allowed us to refine our efforts. We visited several dozen areas within the park to

- Refine the working vegetation classification system,
- Identify photo signatures for different communities,
- Check the gradsect-identified areas and determine where to sample, and
- Review the sampling protocol with the field ecologists.

Field Sampling

We sampled 179 areas, 63 in 1997, 107 in 1998, and 9 in 1999 during field data collection for accuracy assessment (Figure 6). Methods were derived from those in Section 5 of the Field Methods for Vegetation Mapping manual (The Nature Conservancy and Environmental Systems Research Institute 1994b). For Acadia NP, the plot sampling design was modified to make sampling congruent with other natural community sampling efforts in Maine while still compatible with the standards specified for this project (Table 4). The major difference was that rather than one large plot for a sample, we used four smaller subplots and nested subplots within those for the different vegetation layers. This we found to lessen plot location bias, incorporated more of the within-community variability, and reduced observer bias in cover estimates.

The initial step for a sample (hereafter referred to as a "plot" even though it consists of four subplots) is locating the center of the sampling area. This is the point at which the GPS reading is taken and from which the subplots radiate (Figure 7). For communities not dominated by trees, the layout is the same, with the largest subplot corresponding to the tallest layer. In a shrub swamp, for example, four 25-m^2 subplots with nested herb plots would be the sample. In a peatland community dominated by dwarf shrubs and herbs, the sample would be 16 1-m^2 subplots, 4 in each of the cardinal directions from the plot center point. Additional specifications are that, where possible, the outer edges of the subplots be at least 30 m from the edge of the community polygon; but in communities wherein the shape does not allow placing the four subplots in the cardinal directions, subplots may be placed four-in-line.

Recording of percent cover for each species also differs somewhat from the method recommended in the manual. For the tree layer, all diameters (dbh, diameter at breast height) are recorded by species, allowing calculation of basal area values. Relative dominance (RD) is calculated for each species as the percentage

of the total basal area made up of that species. Percent cover of each species is derived as the relative dominance of a species times the total cover of the canopy.
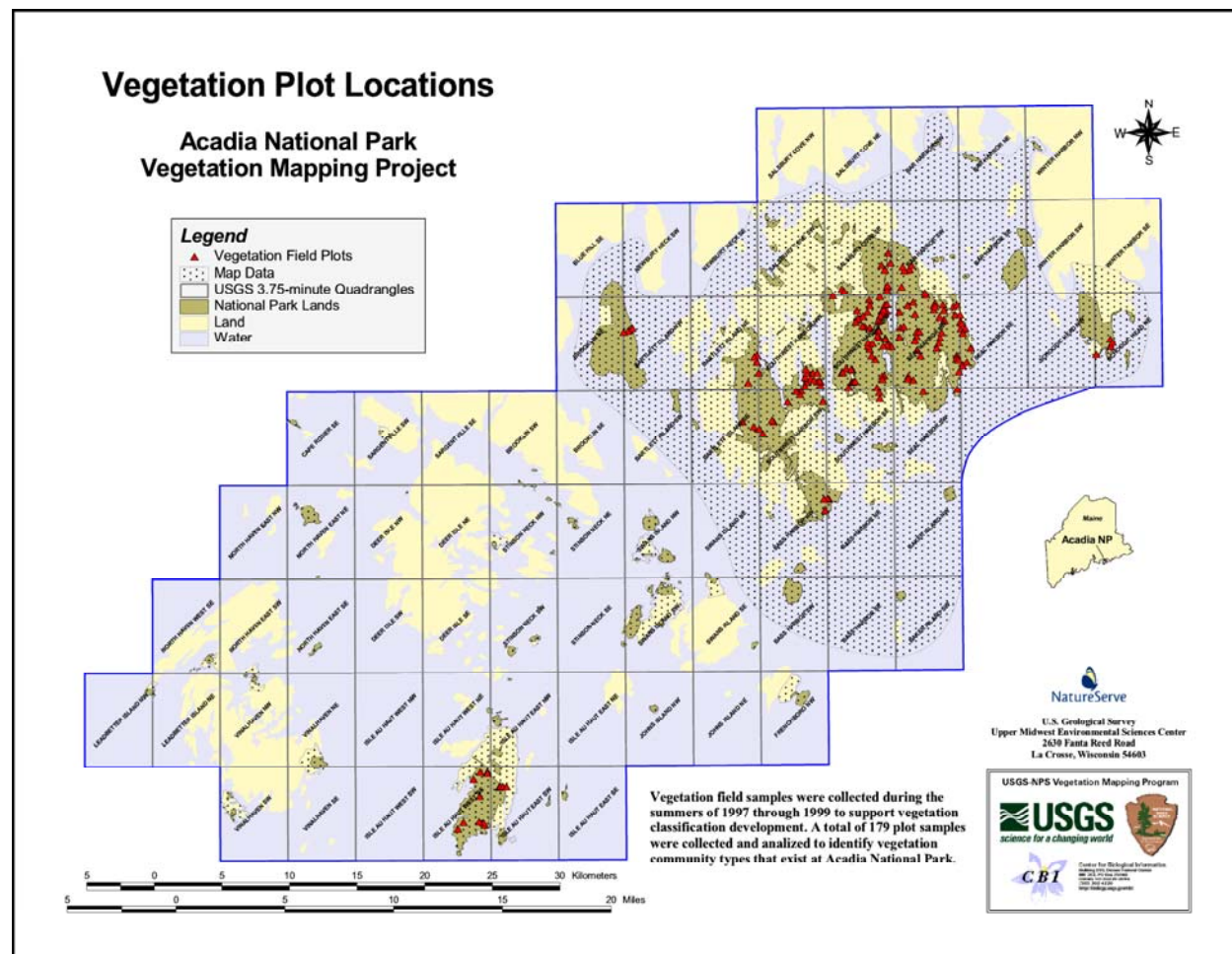
Figure 6. Locations of vegetation plots sampled for the Acadia National Park Vegetation Mapping Project.

Table 4. Vegetation data layers collected with each sample plot.

Layer	Description
Tree	woody stems ≥ 10 cm dbh (diameter at breast height)
Sapling / tall shrub	woody stems < 10 cm dbh and > 3 m tall
Shrub	all woody plants 1 – 3 m tall
Herb	all vascular plants < 1 m tall (segregating woody plants from herbs)
Bryoid	bryophytes and lichens on the ground

General Plot Layout

subplot

Plot Center

subplot

15 m from plot center to subplot center, N – S – E - W

subplot

subplot

0.02 ha (200 m²) nested subplot (detail below)

Subplot

Tree layer, 7.98 m radius (200 m²)

Sapling and tall/medium shrub layers, 2.8 m radius (25 m²)

Dwarf shrub, herb, and bryoid layers, 4 quadrats @ 1 m², equidistant from center
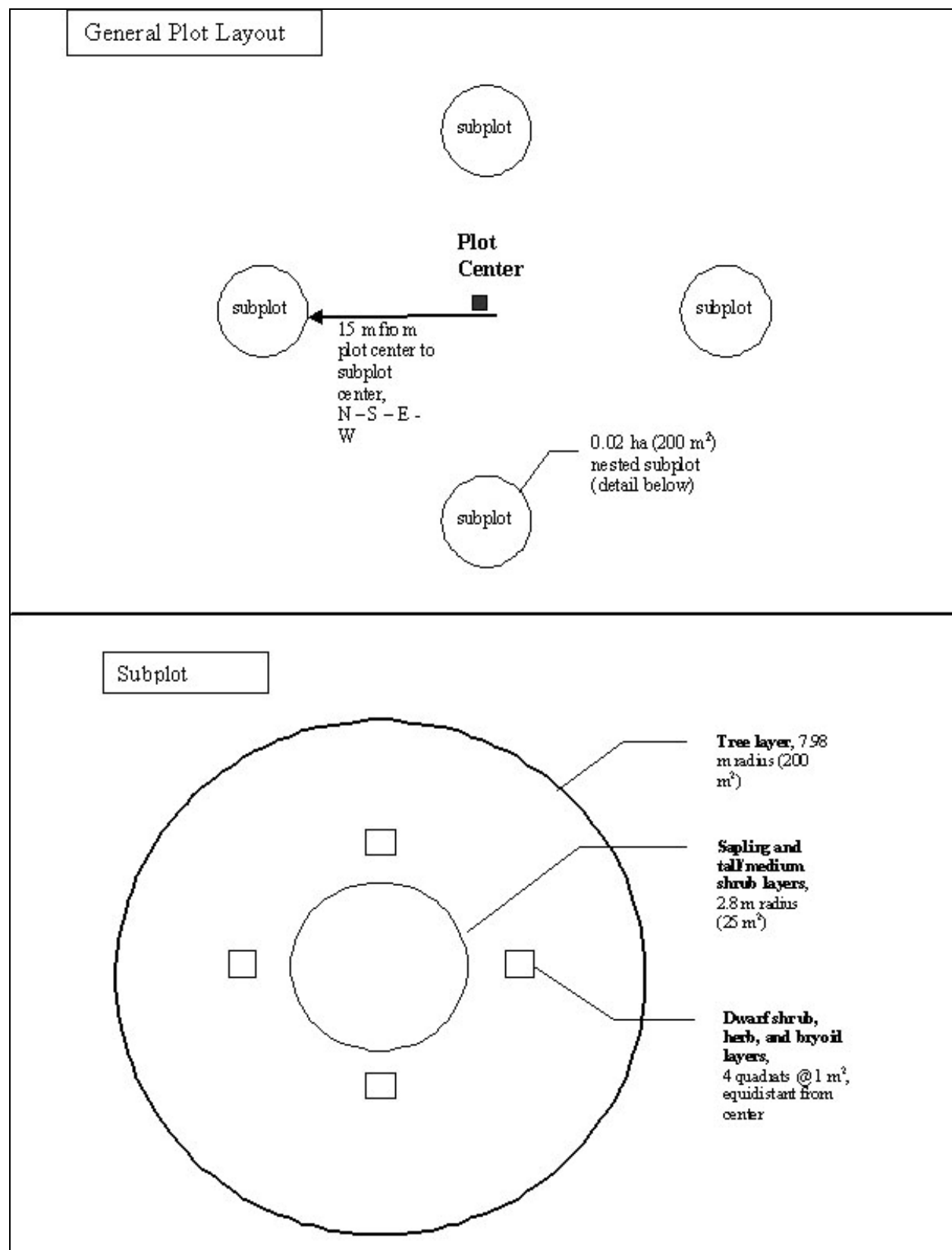
Figure 7. Plot sampling layout for the Acadia National Park.Vegetation Mapping Project. Plots without a tree canopy used the same design, but without the 200 m² outer subplot.

Within each layer below the tree layer, cover class midpoint is recorded in each subplot for each species (Table 5). After trying various cover estimations and permutations of classes, we settled on a 7-point cover scale with which our field crews were accustomed, similar to the Braun-Blanquet scale but omitting sociability.

Table 5. Cover class 7-point scale.

Percent cover	Cover class midpoint
<2	1
2–5	3
6–12	9
13–24	19
25–49	37
50–74	63
75–100	87

Subplot cover midpoints are averaged for the whole plot. Four values are averaged for tree, sapling, and shrub layers and 16 for herb and bryoid layers. Zeros are included for subplots wherein the species is absent. The species average can be used as a cover value on other scales (e.g., it can be entered as the nearest class midpoint on the 12-point scale in the mapping manual. Environmental data were collected in the vicinity of the overall plot center (the GPS point), following the methods given in the manual.

Vegetation Data Analysis for Vegetation Classification Development

Vegetation field sampling data were entered into a modified version of The PLOTS Database (The Nature Conservancy 1997) at the Maine Natural Areas Program, which (after checking the data for accuracy) was used to produce plot vegetation summaries and associated environmental information. Along with the 179 samples collected specifically for this project were 38 additional samples collected in 1995 as part of the Maine Ecological Reserves inventory (which followed a congruent data collection method) for a total of 216 complete plots. Tree layer information was available for an additional 33 plots sampled by Mittelhauser et al. (1994); these data were not used in the ordinations but were helpful in developing the descriptions.

Percent cover data for each plot were exported as matrices (species by samples) for multivariate analysis in PC-ORD 4.0 (McCune and Mefford 1999). MS Excel was used as an intermediate tool to prepare the matrices for compatibility with PC-ORD.

To analyze vegetation patterns and classify types, we used Detrended Correspondence Analysis (DCA), Two-Way Indicator Species Analysis (TWINSPAN), and Indicator Species Analysis (ISA) within PC-ORD. An ordination technique, DCA arranges samples along derived axes according to compositional similarity. A divisive polythetic technique, TWINSPAN classifies samples and species, using a similar algorithm to that for DCA. The ISA identifies indicator species for user-defined groups of samples (in this case vegetation types) by calculating an indicator value based on a species' abundance and frequency in each of several defined groups, then using a Monte Carlo test to determine those that are significantly allied with one group as opposed to randomly distributed. Further references for all techniques can be found in the PC-ORD documentation (McCune and Mefford 1999).

Data for each plot were relativized so that the cover values for the plot totaled 1 (relativization by the maximum by sample); this removed variation due to differences in total amount of vegetation among plots and resulted in clearer ordinations.

Different matrices were used for different subsets of the data, such as all upland forests and woodlands, all non-forested non-tidal wetlands, all tidal wetlands, etc. Progressive analyses, looking at a larger matrix for general patterns and then deriving submatrices for more detailed analyses, allowed the identification of larger and smaller groups of community types. For each samples-by-species matrix, a secondary matrix (samples by associated variables) contained additional information for interpreting the ordinations. These secondary variables included environmental measures such as slope, aspect, elevation, topographic position, hydrologic regime, soil texture and drainage, latitude, and longitude, as well as summary variables such as the total coverage of each vegetation layer in the sample, the relative importance of dwarf shrubs versus herbs, and the percent of conifer versus deciduous trees in the canopy.

Defining vegetation types was an iterative process with the following steps:

- Overlay DCA ordinations with vegetation type as assigned in the field;
- Use those to look for gross patterns, environmental gradients, and to look for possibly misassigned samples;
- Recode samples' vegetation type where needed and re-plot the DCA;
- Run TWINSPAN and plot results onto the DCA ordination to see how the major TWINSPAN breaks correspond to the evolving vegetation type differences;
- Further refine type assignments, and split data set for further ordinations, based on TWINSPAN distinctions and on review of compositional similarities of closely plotted samples;
- Run DCA on smaller data sets to try for better discrimination among the messy types, and use TWINSPAN to look for indicators;
- Recode samples' vegetation type as appropriate; and
- Re-run DCA and TWINSPAN with final vegetation type assignments and apply ISA.

A single technique such as TWINSPAN can give useful results when dealing with a relatively small group of vegetation types to classify and where reasonably comprehensive data are available. With a project of this scale, however, dealing with all vegetation types within the park, and with far fewer than the 10 samples per type average recommended in the manual, multiple techniques are combined to identify vegetation types. The vegetation types derived do not necessarily perfectly match those that TWINSPAN would produce from the data at hand. Instead, ordination and classification results are used to identify important gradients or factors in the data, which are then used to develop diagnostics for different vegetation types. Once types have thus been refined, DCA can be re-run to show the relations and overlaps between vegetation types, and ISA can be used to determine which species are most diagnostic for particular types.

Whereas vegetation types were being developed and refined from the sample data, reference to the NVCS (Anderson et al. 1998) had to be maintained. The required consultations with TNC regional ecologists to (1) determine if an existing NVCS type fit the Acadia type; (2) if no existing NVCS type matched, whether it made sense to refine an existing type or to create a new type; and (3) if a new type was indicated, to name and describe that type.

Mapping the Vegetation of Acadia National Park

The process of vegetation mapping involved four integrated primary steps, (1) field reconnaissance, (2) map classification, (3) photointerpretation, and (4) digital map automation.

Field Reconnaissance

Field reconnaissance helped us relate vegetative photo signatures (appearances of vegetation on the aerial photographs) to vegetation on the ground and become familiar with the local ecology, which is important when we apply ecological concepts to our photointerpretation mapping. This field effort required visiting numerous sites in the field to learn, test, and verify photo signatures. We collected 46 observation points (Figure 8) to verify vegetation communities and to document the relations between field and aerial photo perspectives. Ground coordinates were collected with Rockwell Precision Lightweight Global Positioning System Receiver (PLGR) GPS units. Formal data sheets were used to document the field participants, location information (including GPS coordinates), aerial photo relations (including photo signature), ground survey of plants, classification, and general observations and discussions about the site (Appendix A: Example of Observation Field Reconnaissance Form).
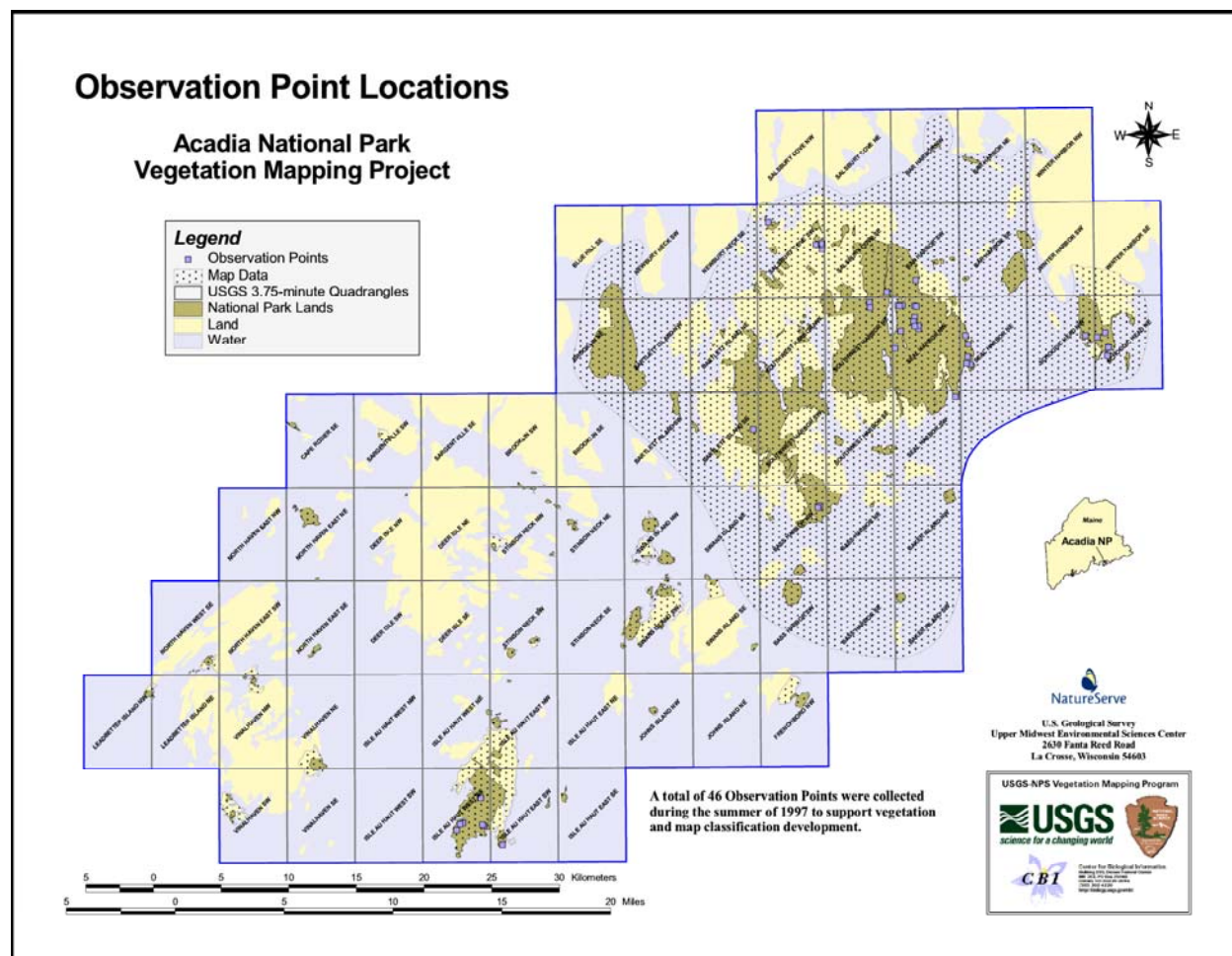
Figure 8. Locations of observation points collected for the Acadia National Park Vegetation Mapping Project.

Besides collecting formal reconnaissance data, we "ground-truthed" additional sites, documenting our discoveries on photo sleeves covering the print CIR photos and in field notebooks (Figure 9). Our field notes included dominant species (or the vegetation type, if known), tree heights, and other information that would help us link the photo signature to an appropriate map class. With the Acadia NP extensive trails and carriage roads, hiking was the primary mode of travel. However, some "ground-truthing" was done during frequent vehicle stops along roadsides with good vistas. Bicycles were another handy mode of travel on the carriage roads, with stops and short hikes to view signatures of interest. The park service also provided ferry service to Isle au Haut and Long Island, where we hiked to habitats of interest. The first reconnaissance trip was in June 1997, with two more trips in September 1997 and June 1998. During the last trip, we took some of the preliminary interpretation to validate in the field.

Figure 9. Field botanists and photointerpreters "ground-truthing" in Acadia National Park.

During our reconnaissance, we became familiar with the vegetation and local ecology, especially on days when we were accompanied by the ecologists. We discussed the structural, floristic, and habitat characteristics of the vegetation encountered in the field, and compared them to their appearances on the photos. We referred to the preliminary list of vegetation types, providing us some concept of their global (regional) characterization (local descriptions were developed after the mapping). Through this process, we built an understanding of how to map the vegetation types (or anticipated types). Two ecologists from TNC and NPS accompanied us on a few days of the fieldwork and were instrumental in helping us understand the vegetation patterns we encountered and their relations to the NVCS.

Map Classification

Following the initial reconnaissance trip, we began to define map classes (units that represent vegetation types or other ground features) based on further inspection of the aerial photographs. Using stereoscopes, we viewed photo signature characteristics to determine their relations to a list of vegetation types validated in the field. As determined from the initial scoping (planning) meeting, our fieldwork and photointerpretation mapping was to proceed simultaneously with vegetation sampling and subsequent analysis. We had to develop a map classification prior to having a complete understanding of the vegetation types. We relied on NVCS concepts and a draft list of vegetation communities as the basis for mapping vegetation of Acadia NP and environs.

During the early stages of photointerpretation, new questions surfaced regarding the map classes and we soon discovered that we could not always determine where to draw boundary lines between vegetation types. Thus, we organized a meeting at the UMESC with the mappers and ecologists in spring 1998 to help both parties understand the relations between photo signatures and vegetation types (Figure 10). This meeting was very helpful for all of us; the classifiers were able to better understand the challenges of applying the classification and the mappers were able to better understand how to interpret the vegetation types on the aerial photos. However, a final vegetation classification, key, and descriptions of each NVCS vegetation association were not available until after the mapping was completed.

Figure 10. Mappers and ecologists examine aerial photographs to understand vegetation appearance.

In addition to developing map classes to reflect NVCS types, we also developed map classes to represent other general land cover situations, such as urban areas and non-vegetated bodies of water. For these map classes, we used a combination of the USGS land use/land cover classification (Anderson et al. 1976) and some project-derived map classes.

Photointerpretation

Preparation of the aerial photographs for interpretation generally follows procedures of Owens and Hop (1995). We placed clear acetate overlays onto each aerial photograph transparency that would be used for mapping. We registered each overlay to the photos by demarking the fiducials and photo identification information. We viewed the aerial photo transparencies for interpretation using light tables and Bausch and Lomb Zoom 240 stereoscopes over a Richards MIM2 light table (Figure 11). We paired up each transparency photo with the adjacent photo so we could view the images 3-dimensionally. Only the middle portion of each photograph was used for photointerpretation to minimize edge distortion. We delineated feature polygons and scribed their corresponding map class codes onto the acetate overlays using Rapidograph ink pens.

Figure 11. Bausch and Lomb Zoom 240 stereoscope over a Richards MIM2 light table.

We delineated larger polygons first, with smaller polygons following, down to a minimum size of 0.5 ha (with the exception of small islands within wetlands and ocean, which were mapped to a minimum size of 0.1 ha). We applied standard photo signature characteristics, including texture, color, pattern, and position in the landscape to guide our polygon delineation placement. In addition to photo signature characteristics, knowledge of the environmental distribution of the types helped us to identify vegetation types and properly place polygon boundaries. For each polygon, the appropriate map class code and physiognomic modifier codes (Table 6) were applied.

Table 6. Physiognomic modifiers assigned to polygons during photointerpretation.

Catagory	Modifier	Meaning
Coverage density	1	Closed Canopy/Continuous (60-100% cover)
	2	Open Canopy/Discontinuous (25-60% cover)
	3	Dispersed-Sparse Canopy (10-25% cover)
Coverage pattern	A	Evenly Dispersed
	B	Clumped/Bunched
	C	Gradational/Transitional
	D	Regularly Alternating
Height	1	30-50 meters (98-162 feet)
	2	20-30 meters (65-98 feet)
	3	12-20 meters (40-65 feet)
	4	5-12 meters (16-40 feet)
	5	0.5-5 meters (1.5-16 feet)
	6	<0.5 meters (<1.5 feet)

Digital Map Automation

To geo-reference the photo interpreted data, we used Bausch and Lomb zoom transfer scopes to manually transfer the polygons onto drafting film over base maps (Figures 12–13). The transfer process removes much of the aerial photograph's inherent distortion and ties the interpreted data to real-world coordinates so it can be digitally automated. Sixty-five USGS 3.75-minute digital orthophoto quadrangles (DOQ) were used to plot hard copy (film acetate) orthophoto base maps at a scale of 1:12,000 (Figure 14). The polygons were manually transferred to overlays that were registered to the base maps. Map class attributes and appropriate physiognomic modifiers were added to a second overlay. The overlays were subsequently rechecked for accuracy. Each overlay of transferred data was scanned using a large format sheet fed scanner with a resolution of 400 dots per inch (Figure 15). The resulting Tagged Image File Format (TIFF) images were then converted to a grid format using ArcInfo (Version 7.2.1 Patch 2, Environmental Systems Research Institute, Redlands, California). The grid data was projected to Universal Transverse Mercator (UTM), Zone 19 with datum in North American Datum of 1983 (NAD83). Each individual grid was transformed to a geo-referenced boundary coverage to digitally reference the data to real-world coordinates. In ArcTools, the ArcScan utility was used to trace the referenced polygon data creating an ArcInfo coverage. Each individual coverage was then edited for errors, assigned attributes to polygons, checked against the hand-transferred overlays for line and attribute errors, and then joined to create a seamless coverage of the vegetation map.

We originally produced the map attribute table in spreadsheet format (dBASE IV) with the items listed in Table 7. The attribute table contains numerous items that, when linked to the coverage, offers a set of information for each polygon. We converted the dBASE IV table to an ArcInfo table using ArcInfo (Version 8.0.2, Environmental Systems Research Institute, Redlands, California). We then merged the table with the spatial database coverage. In addition to the items listed in Table 7, ArcInfo default items are also included in the final map coverage (e.g., perimeter, area, and polygon identification numbers). ArcInfo was used to produce the ArcInfo Export and Spatial Data Transfer Standard files of the map coverage.

Figure 12. Transferring photointerpreted data to base maps using a zoom transfer scope.

Figure 13. Closeup of zoom transfer mapping process.
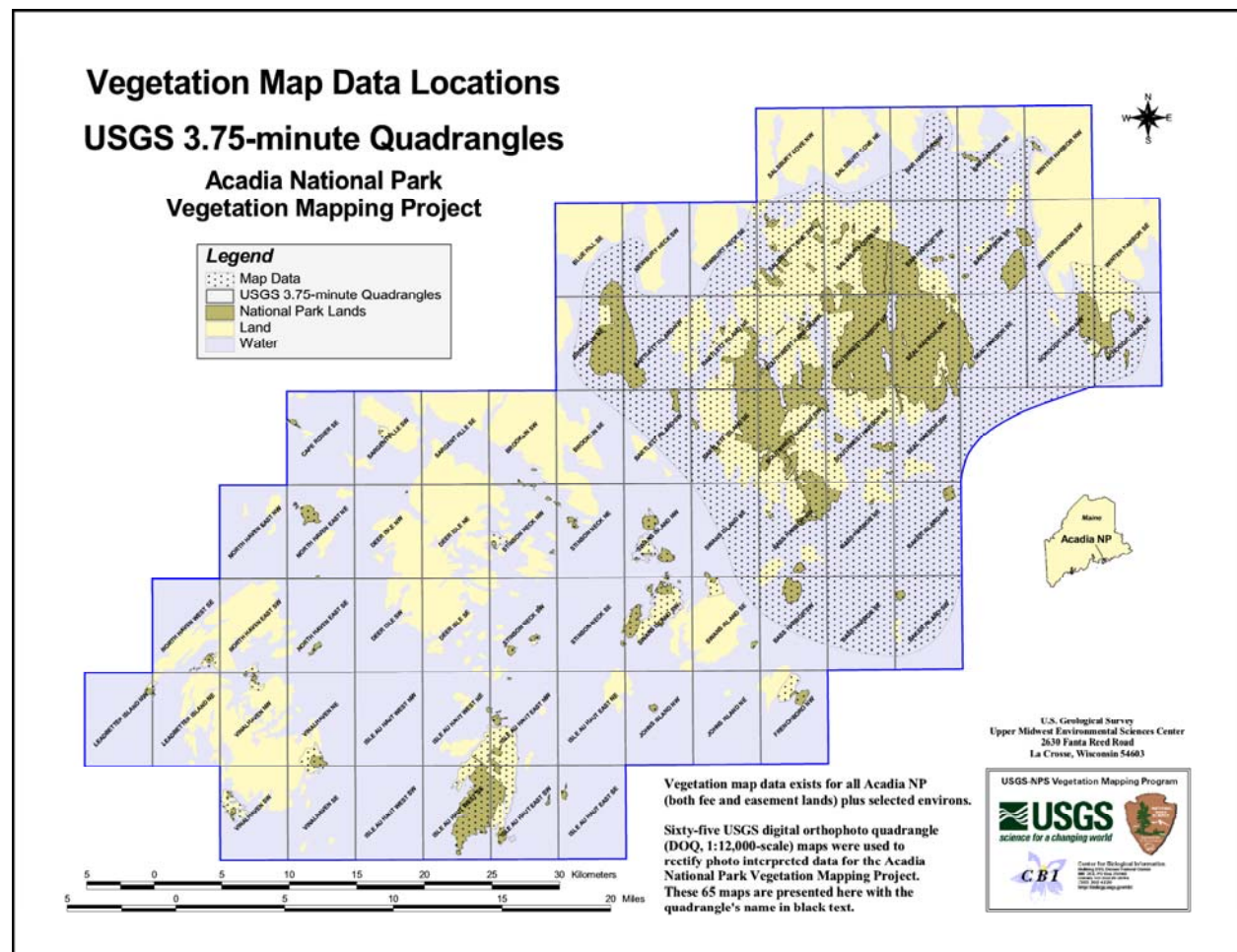
Figure 14. Extent of the vegetation map coverage for the Acadia National Park Vegetation Mapping Project.
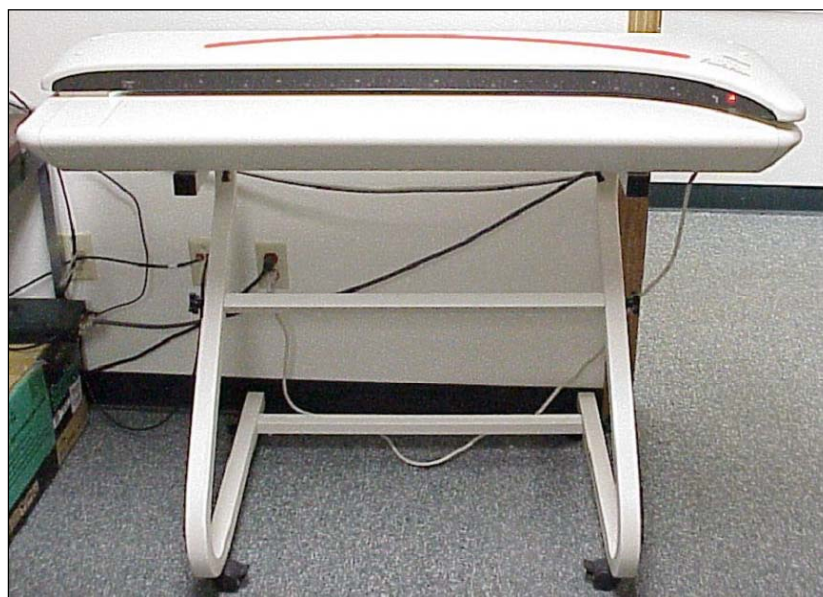
Figure 15. Large format scanner used to scan overlays into electronic files.

Table 7. Items included in the vegetation map coverage's attribute database table.

Code	Definition
MAP_CODE	Map Class Code - project derived
MAP_DESC	Map Class Description Name - project derived
MAP_ATT	Map Class Code with all applicable Physiognomic Modifier codes
DENS_MOD	Physiognomic Modifier - Coverage Density (all vegetation map classes)
PTRN_MOD	Physiognomic Modifier - Coverage Pattern (all vegetation map classes)
HT_MOD	Physiognomic Modifier - Height (woody terrestrial vegetation map classes)
PHYS_HYDR	Physiognomic - Hydrologic Category - Maine Natural Areas Program
MAINE_CLSF	Maine Natural Community Classification - Maine Natural Areas Program
ECO_SYSTEM	U.S. Terrestrial Ecological System Classification (name & code) - NatureServe
ASSN_SNAME	National Vegetation Classification System Association (scientific name) - NatureServe
ASSN_TNAME	NVCS Association (translated common name) - NatureServe
ASSN_CNAME	NVCS Association (synonym name) - NatureServe
ASSN_CEGL	Community Element Global Code (Elcode link to Association) - NatureServe
NVCS_CODE	NVCS Code (to Alliance level) - FGDC
CLASS	NVCS Formation Class (code & name) - FGDC
SUBCLASS	NVCS Formation Subclass (code & name) - FGDC
GROUP	NVCS Formation Group (code & name) - FGDC
SUBGROUP	NVCS Formation Subgroup (code & name) - FGDC
FORMATION	NVCS Formation (code & name) - FGDC
ALL_SNAME	NVCS Alliance Name (code & scientific name) - NatureServe
ALL_TNAME	NVCS Alliance Name (translated common name) - NatureServe
LUC_II	Land Use and Land Cover Classification System (code & name) - USGS

Results and Discussion

Vegetation Classification

Our initial provisional list of 56 types was augmented, winnowed, and reshuffled into the 53 vegetation types here recognized and described for Acadia National Park.

10 upland forest types
13 upland woodland types
2 wetland forest types
3 wetland woodland types
6 non-forested upland types
6 shrub or dwarf shrub wetland types
13 herbaceous wetland types

Results of the vegetation data analyses along with ordination diagrams are presented in Appendix D: Ordination Diagrams and Results of the Vegetation Data Analysis. Table 8 provides a listing of the 53 vegetation associations identified and described at the Acadia NP vegetation mapping project.

Table 8. National Vegetation Classification System associations (vegetation communities) recognized at Acadia National Park.

NVCS Vegetation Community Name (NatureServe Association)	NVCS Common Community Name (NatureServe Association)	NatureServe CEGL Code	NVCS Code
Upland Forest Types			
Pinus strobus - Tsuga canadensis - Picea rubens Forest	Eastern Hemlock - White Pine - Red Spruce	CEGL006324	I.A.8.N.b.13
Pinus strobus - Pinus resinosa / Cornus canadensis Forest	Red Pine - White Pine Forest	CEGL006253	I.A.8.N.b.14
Picea rubens - Picea glauca Forest	Maritime Spruce - Fir Forest	CEGL006151	I.A.8.N.c.15
Acer saccharum - Betula alleghaniensis - Fagus grandifolia / Viburnum lantanoides Forest	Northern Hardwood Forest	CEGL006252	I.B.2.N.a.4
Quercus rubra - Acer rubrum - Betula spp. - *Pinus strobus* Forest	Successional Oak - Pine Forest	CEGL006506	I.B.2.N.a.39
Picea rubens - Betula alleghaniensis / Dryopteris campyloptera Forest	Red Spruce - Hardwoods Forest	CEGL006267	I.C.3.N.a.4
Picea rubens - Abies balsamea - Betula spp. - *Acer rubrum* Forest	Successional Spruce - Fir Forest	CEGL006505	I.C.3.N.a.4
Pinus strobus - Quercus (rubra, velutina) - Fagus grandifolia Forest	White Pine - Oak Forest	CEGL006293	I.C.3.N.a.21
Tsuga canadensis - (Betula alleghaniensis) - Picea rubens / Cornus canadensis Forest	Hemlock - Hardwood Forest	CEGL006129	I.C.3.N.a.32
Acer saccharum - Pinus strobus / Acer pensylvanicum Forest	Sugar Maple - White Pine Forest	CEGL005005	I.C.3.N.a.300
Upland Woodland Types			
Pinus banksiana / Kalmia angustifolia - Vaccinium spp. Woodland	Jack Pine Heath Barren	CEGL006041	II.A.4.N.a.9
Pinus rigida / Vaccinium spp. - *Gaylussacia baccata* Woodland	Pitch Pine / Blueberry spp. - Huckleberry Woodland	CEGL005046	II.A.4.N.a.26

NVCS Vegetation Community Name (NatureServe Association)	NVCS Common Community Name (NatureServe Association)	NatureServe CEGL Code	NVCS Code
Pinus rigida / Photinia melanocarpa / Deschampsia flexuosa - Schizachyrium scoparium Woodland	Pitch Pine Rocky Summit	CEGL006116	II.A.4.N.a.26
Pinus rigida / Corema conradii Woodland	Coastal Pitch Pine Outcrop Woodland	CEGL006154	II.A.4.N.a.26
Thuja occidentalis / Gaylussacia baccata - Vaccinium angustifolium Woodland	White-cedar Woodland	CEGL006411	II.A.4.N.b.1
Thuja occidentalis - Fraxinus pennsylvanica / Acer pensylvanicum Woodland	Cedar Seepage Slope	CEGL006508	II.A.4.N.b.1
Picea rubens / Vaccinium angustifolium - Sibbaldiopsis tridentata Woodland	Spruce - Fir Rocky Summit	CEGL006053	II.A.4.N.b.3
Picea rubens / Ribes glandulosum Woodland	Red Spruce Talus Slope Woodland	CEGL006250	II.A.4.N.b.3
Picea mariana / Kalmia angustifolia Woodland	Black Spruce / Heath Rocky Woodland	CEGL006292	II.A.4.N.b.400
Populus (tremuloides, grandidentata) - Betula (populifolia, papyrifera) Woodland	Early Successional Woodland/Forest	CEGL006303	II.B.2.N.a.10
Quercus rubra - (Quercus prinus) / Vaccinium spp. / *Deschampsia flexuosa* Woodland	Central Appalachian High-Elevation Red Oak Woodland, Northern Variant	CEGL006134	II.B.2.N.a.24
Betula alleghaniensis - Quercus rubra / Polypodium virginianum Woodland	Red Oak Talus Slope Woodland	CEGL006320	II.B.2.N.a.24
(Pinus strobus, Quercus rubra) / Danthonia spicata Acid Bedrock Wooded Herbaceous Vegetation	White Pine - Oak Acid Bedrock Glade	CEGL005101	V.A.5.N.e.8

Wetland Forest Types

NVCS Vegetation Community Name (NatureServe Association)	NVCS Common Community Name (NatureServe Association)	NatureServe CEGL Code	NVCS Code
Acer rubrum - Fraxinus spp. / *Nemopanthus mucronatus - Vaccinium corymbosum* Forest	Northern Hardwood Seepage Swamp	CEGL006220	I.B.2.N.e.1
Picea rubens - Acer rubrum / Nemopanthus mucronatus Forest	Red Maple - Conifer Acidic Swamp	CEGL006198	I.C.3.N.d.10

Wetland Woodland Types

NVCS Vegetation Community Name (NatureServe Association)	NVCS Common Community Name (NatureServe Association)	NatureServe CEGL Code	NVCS Code
Thuja occidentalis - Abies balsamea / Ledum groenlandicum / Carex trisperma Woodland	Northern White-cedar Wooded Fen	CEGL006507	II.A.4.N.f.11
Picea mariana / (Vaccinium corymbosum, Gaylussacia baccata) / Sphagnum sp. Woodland	Black Spruce Woodland Bog	CEGL006098	II.A.4.N.f.13
Acer rubrum / Alnus incana - Ilex verticillata / Osmunda regalis Woodland	Red Maple Swamp Woodland	CEGL006395	II.B.2.N.e.1

Non-forested Upland Types

NVCS Vegetation Community Name (NatureServe Association)	NVCS Common Community Name (NatureServe Association)	NatureServe CEGL Code	NVCS Code
Morella pensylvanica - Empetrum nigrum Dwarf-shrubland	Crowberry - Bayberry Maritime Shrubland	CEGL006510	IV.A.1.N.b.7
Vaccinium angustifolium - Sorbus americana / Sibbaldiopsis tridentata Dwarf-shrubland	Blueberry Granite Barrens	CEGL005094	IV.B.2.N.a.1
Ammophila breviligulata - Lathyrus japonicus Herbaceous Vegetation	Northern Beachgrass Dune	CEGL006274	V.A.5.N.c.2
Polypodium (virginianum, appalachianum) / Lichen spp. Nonvascular Vegetation	Northern Lichen Talus Barrens	CEGL006534	VI.B.1.N.c.300
Solidago sempervirens - (Rhodiola rosea) - Juniperus horizontalis Sparse Vegetation	Northern Maritime Rocky Headlands	CEGL006529	VII.A.2.N.a.4

NVCS Vegetation Community Name (NatureServe Association)	NVCS Common Community Name (NatureServe Association)	NatureServe CEGL Code	NVCS Code
Cakile edentula ssp. *edentula - Mertensia maritima* Sparse Vegetation	Sea-rocket - Oysterleaf Sparse Vegetation	CEGL006106	VII.C.2.N.a.2

Shrub or Swarf Shrub Wetland Types

Alnus incana - Cornus sericea / Clematis virginiana Shrubland	Alluvial Alder Thicket	CEGL006062	III.B.2.N.d.9
Alnus incana ssp. *rugosa - Nemopanthus mucronatus / Sphagnum* spp. Shrubland	Northern Peatland Shrub Swamp	CEGL006158	III.B.2.N.e.9
Myrica gale - Spiraea alba - Chamaedaphne calyculata Shrubland	Sweetgale Mixed Shrub Swamp	CEGL006512	III.B.2.N.g.9
Kalmia angustifolia - Chamaedaphne calyculata - (Picea mariana) / Cladina spp. Dwarf-shrubland	Northern Dwarf-shrub Bog	CEGL006225	IV.A.1.N.g.1
Chamaedaphne calyculata / Eriophorum virginicum / Sphagnum rubellum Dwarf-shrubland	Leatherleaf Acidic Fen	CEGL006513	IV.A.1.N.g.1
Empetrum nigrum - Gaylussacia dumosa - Rubus chamaemorus / Sphagnum spp. Dwarf-shrubland	Maritime Crowberry Bog	CEGL006248	IV.A.1.N.g.4

Herbaceous Wetland Types

Trichophorum caespitosum - Gaylussacia dumosa / Sphagnum (fuscum, rubellum, magellanicum) Herbaceous Vegetation	Maritime Peatland Sedge Lawn	CEGL006260	V.A.5.N.h.1
Carex stricta - Carex vesicaria Seasonally Flooded Herbaceous Vegetation	Eastern Tussock Sedge Meadow	CEGL006412	V.A.5.N.k.36
Calamagrostis canadensis - Scirpus spp. *- Dulichium arundinaceum* Herbaceous Vegetation	Seasonally Flooded Mixed Graminoid Meadow	CEGL006519	V.A.5.N.k.39
Schoenoplectus (tabernaemontani, acutus) Eastern Herbaceous Vegetation	Bulrush Deepwater Marsh	CEGL006275	V.A.5.N.l.16
Eriocaulon aquaticum - Lobelia dortmanna Herbaceous Vegetation	Seven-angle Pipewort - Dortmann's Cardinal-flower Herbaceous Vegetation	CEGL006346	V.A.5.N.l.2
Juncus militaris Herbaceous Vegetation	Bayonet Rush Herbaceous Vegetation	CEGL006345	V.A.5.N.l.3
Typha (angustifolia, latifolia) - (Schoenoplectus spp.) Eastern Herbaceous Vegetation	Eastern Cattail Marsh	CEGL006153	V.A.5.N.l.9
Carex (lasiocarpa, utriculata, canescens) Herbaceous Vegetation	Slender Sedge Fen	CEGL006521	V.A.5.N.m.7
Spartina patens - Distichlis spicata - (Juncus gerardii) Herbaceous Vegetation	Spartina High Salt Marsh	CEGL006006	V.A.5.N.n.11
Typha angustifolia - Hibiscus moscheutos Herbaceous Vegetation	Brackish Tidal Marsh, Cattail Variant	CEGL004201	V.A.5.N.n.2
Carex (oligosperma, exilis) - Chamaedaphne calyculata Shrub Herbaceous Vegetation	Few-seeded Sedge - Leatherleaf Fen	CEGL006524	V.A.7.N.o.3
Vallisneria americana - Potamogeton perfoliatus Herbaceous Vegetation	Open Water Marsh with Mixed Submergents/Emergents	CEGL006196	V.C.2.N.a.17
Nuphar lutea ssp. *advena - Nymphaea odorata* Herbaceous Vegetation	Water Lily Aquatic Wetland	CEGL002386	V.C.2.N.a.102

Map Classification

Map classes that represent nautral/semi-natural vegetation types of the NVCS reflect the vegetation classification as close as possible based on what we knew at the time of mapping (which was before the vegetation classification was developed) and what we learned through the accuracy assessment (which was after the vegetation classification was developed). Our original list of map classes was rearranged several times before we began the photointerpretation, and several adjustments to the map classification and mapping concepts were made as we proceeded with the mapping process.

We made our largest adjustment to the map classification during the accuracy assessment when we proceeded with an in depth review of field assessment sites and map data discrepancies. As discussed earlier, it was then we realized some consistent divergence between the map and vegetation classifications. (It was our conclusion that this was because of (1) mapping before the vegetation classification was developed and (2) using spring photography that hindered the interpretability of deciduous tree components and of herbaceous wetlands. For more discussion on this, see the Recommendations section of this report.) At this point, we combined several map classes to better align with the vegetation classification based on final vegetation community descriptions and results of the accuracy assessment.

We finalized the map classification with 33 map classes representing NVCS natural/semi-natural vegetation associations (NatureServe 2003) that we identified at Acadia NP with this mapping project (Appendix E: Vegetation Classification Matrix show the relations between vegetation map classes and NVCS vegetation communities). Including land use/land cover features and some park specific features, 57 map classes (58 including the class for no map data) were developed for the Acadia NP Vegetation Mapping Project (Table 9; Map Classification for Acadia National Park Vegetation Mapping Project). Table 10 shows the number of map classes broken out by general categories.

Table 9. Map Classification for the Acadia National Park Vegetation Mapping Project.

MAP CLASS CODE	MAP CLASS NAME
Forest - Conifer - Upland	
SF	Spruce - Fir Forest (conifer phase)
WPC	White Pine - Mixed Conifer Forest
WRP	Red Pine - White Pine Forest
Forest - Deciduous - Upland	
MDF	Beech - Birch - Maple Forest
Forest - Mixed - Upland	
OPF	Oak - Pine Forest
SFM	Spruce - Fir Forest (mixed phase)
WPM	White Pine - Hardwood Forest
Woodland - Conifer - Upland	
MCW	Mixed Conifer Woodland
WCW	White Cedar Woodland
JPW	Jack Pine Woodland
PPB	Pitch Pine - Heath Barren

MAP CLASS CODE	MAP CLASS NAME
PPC	Pitch Pine - Corema Woodland
PPW	Pitch Pine Woodland
Woodland - Deciduous - Upland	
ABF	Aspen - Birch Woodland/Forest Complex (forest phase)
ABW	Aspen - Birch Woodland/Forest Complex (woodland phase)
ABS	Aspen - Birch Woodland/Forest Complex (shrubland phase)
ROW	Red Oak Woodland
Woodland - Mixed - Upland	
MW	Mixed Conifer - Deciduous Woodland
Forest - Deciduous - Wetland	
MAS	Red Maple - Hardwood Swamp
Woodland - Conifer - Wetland	
CSW	Conifer Swamp Woodland (spruce-mixed phase)
WCS	Conifer Swamp Woodland (white cedar phase)
Dwarf Shrubland - Evergreen - Upland	
CB	Crowberry - Bayberry Headland
Dwarf Shrubland - Deciduous - Upland	
BBSS	Blueberry Bald - Summit Shrubland Complex
Graminoid - Upland	
AM	Dune Grassland
Sparse Vascular - Upland	
SVH	Open Headland - Beach Strand
SVT	Sparsely Vegetated Talus
Shrubland - Deciduous - Wetland	
ASP	Alder Shrubland
SG	Sweetgale Mixed Shrub Fen
Dwarf Shrubland - Evergreen - Wetland	
DSB	Dwarf Shrub Bog
FX	Fen Complex
Graminoid - Wetland	
TG	Tidal Marsh
SMG	Graminoid Shallow Marsh
Forb - Wetland	
OWM	Open Water - Deep Marsh Complex
Tidal Zone	
TZ	Tidal Algal Zone

MAP CLASS CODE	MAP CLASS NAME
TB	Tidal Beach
TM	Tidal Mud Flat
Small Island with Vegetation	
SIT	Small Island with Trees
SIS	Small Island with Shrubs
SIG	Small Island with Grass
SIR	Small Island with Rock
Cultural Vegetation	
EPL	Evergreen Plantation
SMD	Mixed Deciduous Shrubland
MGF	Mixed Grass - Forb
PGCH	Perennial Grass Crops
PGCS	Perennial Grass Crops with Sparse Shrubs
Non-vegetated Water	
WBP	Beaver Pond (non-vegetated)
WNP	Natural Pond (non-vegetated)
WST	Stream (non-vegetated)
WLK	Lake (non-vegetated)
WO	Ocean - Bay - Estuary (non-vegetated)
Land Use	
UR	Residential
UC	Commercial and Services
UT	Transportation and Roads
UM	Mixed Urban or Built-up Land
UBL	Other Urban or Built-up Land
ARB	Other Agricultural Land
BLQ	Strip Mines, Quarries, and Gravel Pits
No Data	
ND	No Data

Table 10. Number of map classes by general category.

# Map classes	General category
33	Natural/Semi-natural Vegetation (NVCS association types)
3	Beach and Tidal Zone (NVCS natural/semi-natural vegetation alliance and formation types)
4	Small Island with Vegetation (small islands 0.1 ha > 0.5 ha, project-derived)
5	Cultural Vegetation (e.g., idle field, plantation, NVCS planted/cultivated types)
5	Non-vegetated Water (e.g., ocean, lake, river, pond, Anderson et al. 1976 and project-derived)
7	Land Use (developed land, Anderson et al. 1976)
1	No Data (defines areas not mapped with project, project-derived)

It is preferred that each vegetation type is mapped with its own unique map class. However, due to limitations inherent in using aerial photographs to identify floristic vegetation components, this is not always possible. Yet, some map classes do relate to vegetation associations on a 1:1 relation. For example, map class White Pine – Red Pine Forest (WPC) ties directly to the Red Pine - White Pine Forest association type. A polygon correctly mapped as WPC will always and only represent this association.

Many map classes represent more than one association. For example, the map class Mixed Conifer Woodland (MCW) includes 4 associations: Cedar Seepage Slope, Spruce - Fir Rocky Summit, Red Spruce Talus Slope Woodland, and Black Spruce / Heath Rocky Woodland. A polygon correctly mapped as MCW will represents one or more of these associations. Although we originally tried to map 3 of these associations separately, we discovered through the accuracy assessment process that we were not successful, mainly due to photo limitations. Black spruce, red spruce, and cedar were not always distinctive from one another, or they occurred together in mixed stands and we were just not able to consistently determine which species dominated the individual stands. We combined other original map classes for similar reasons.

Some of the map classes "share" associations. In other words, an association may be included in more than one map class. The sharing is due, in part, to the fact that not all associations always appear visible as separate entities on the photos. The aerial photographs limit our ability to map different vegetation types as seen and understood by the ecologists. For example, the association Cedar Seepage Slope occurs in the map class MCW and in the map class WCW because we could not consistently recognize cedar on the photographs when occurring on talus, nor could we see the seepage characteristic.

Another example of a map class that shares associations with other map classes is the Fen Complex (FX), which includes a suite of non-forested wetland types that either were not distinctive on the spring photography or occurred in patterns too small to practically delineate. The timing of the photo mission was too early in the season to capture many of the unique signature characteristics of wetland vegetation, and often these wetland types intermingle or grade together. The Fen Complex map class includes associations that were also mapped under other map classes in the wetland shrubland, dwarf-shrubland, and graminoid groups. These other map classes were used when we could clearly see the dominant vegetation in a pattern large enough to map.

Some of the map classes represent the same association. ABF is the forest phase of the Aspen - Birch Woodland/Forest Complex, ABW is the woodland phase, and ABS is the shrubland phase. These map classes were originally thought to be distinctive vegetation types from one another because their physiognomy is different. However, the vegetation classifiers identified all three as being compositionally

similar enough to regard as one vegetation community having different structures. MW, the Mixed Conifer - Deciduous Woodland also includes the Aspen - Birch Woodland/Forest Complex.

The difficulty in having compatible map classes with the vegetation classification is an artifact of the process combined with the challenges of mapping highly transitional vegetation with spring photography. As mentioned previously, vegetation classification work proceeded simultaneously with mapping, and we created map classes before having a complete understanding of the vegetation types and their variability. Although classifiers and mappers recognized that species assemblages change more or less gradually along environmental and geographical gradients, ecotones — especially broad ones between two distinctive types — are problematic in determining where to draw the line. As stated earlier in this report, "Acadia is characterized by a full suite of forest-to-woodland gradations, and it is not always obvious to which class a particular type should be assigned… Many types exhibit both forest and woodland characters: variable canopy closure, and sometimes but not always a well-developed understory." Thus, our attempts at creating map classes that were strongly linked to the ecology prior to knowing the ecology limited our success in mapping the vegetation communities non-ambiguously. As a result, some map classes share associations, and some associations share map classes. Indeed, once vegetation data analysis was completed and the vegetation descriptions written, we realized that many types are not distinctive from a photointerpretation perspective because of their inherent ecological variability. For specific details about each map class and detailed relations to the NVCS, see Appendix F: Map Class Descriptions and Visual Guide.

Non-vegetated map classes represent land use and land cover features not included within the NVCS, such as populated areas, roads, agricultural lands, quarries, and open water bodies that are <10% vegetated. To map these features, a land use and land cover classification system developed by Anderson et al. (1976) was used (to Level II). A few map classes were developed to represent some park specific situations such as small islands that are less than the minimum mapping unit of 0.5 ha but greater than 0.1 ha.

Vegetation Map Summary

Table 11 is an area report of the Acadia NP Vegetation Map. We mapped 96,693 ha (246,347 acres) mapped of Acadia NP and environs. Of this total, 34,174 ha (84,446 acres), or 35%, are NVCS natural/semi-natural vegetated map classes sampled by this mapping project. Other natural/semi-natural vegetation types that were not sampled (e.g., tidal zone communities), small islands with vegetation, and cultural vegetation together make up another 5% of the coverage (4,801 ha, or 11,864 acres). The remaining map classes are non-vegetated land use/land cover (e.g., residential lands, open water). Open water, especially the Ocean-Bay-Estuary and map classes, dominate these non-vegetated classes (over 90% of non-vegetated map classes). Of the total map coverage, 52,872 ha (130,650 acres) is non-vegetated ocean, bays, and estuaries (53% of coverage).

The Spruce - Fir Forests (SF and SFM, conifer and mixed phases) together are found the most extensive vegetated map classes. Indeed, these forests cover over 60% of natural vegetated classes and over half of all vegetated classes. They also have the greatest number of polygons and the largest average area per polygon.

Among the natural vegetated classes, the rarest types both in area and number of polygons are the Dune Grassland (AM), the Pitch Pine variants Pitch Pine - Heath Barren and Pitch Pine - Corema Woodland (PPB and PPC), and the Crowberry - Bayberry Headlands (CB).

Table 11. Area report of the vegetation map coverage, Acadia National Park Vegetetation Mapping Project.

Map code	Map class name		Polygons	Area hectares	Average area hectares
Forest - Conifer - Upland					
SF	Spruce - Fir Forest (conifer phase)		933	12,865	14
WPC	White Pine - Mixed Conifer Forest		111	545	5
WRP	Red Pine - White Pine Forest		9	17	2
		SubTotals	1,053	13,426	13
Forest - Deciduous - Upland					
MDF	Beech - Birch - Maple Forest		54	382	7
		SubTotals	54	382	7
Forest - Mixed - Upland					
OPF	Oak - Pine Forest		48	497	10
SFM	Spruce - Fir Forest (mixed phase)		686	8,371	12
WPM	White Pine - Hardwood Forest		191	1,787	9
		SubTotals	925	10,656	12
Woodland - Conifer - Upland					
MCW	Mixed Conifer Woodland		663	2,327	4
WCW	White Cedar Woodland		8	163	20
JPW	Jack Pine Woodland		40	84	2
PPB	Pitch Pine - Heath Barren		3	9	3
PPC	Pitch Pine - Corema Woodland		1	5	5
PPW	Pitch Pine Woodland		47	380	8
		SubTotals	762	2,968	4
Woodland - Deciduous - Upland					
ABF	Aspen - Birch Woodland/Forest Complex (forest phase)		172	1,184	7
ABW	Aspen - Birch Woodland/Forest Complex (woodland phase)		25	219	9
ABS	Aspen - Birch Woodland/Forest Complex (shrubland phase)		8	105	13
ROW	Red Oak Woodland		62	549	9
		SubTotals	267	2,057	8
Woodland - Mixed - Upland					
MW	Mixed Conifer - Deciduous Woodland		243	1,497	6
		SubTotals	243	1,497	6
Forest - Deciduous - Wetland					
MAS	Red Maple - Hardwood Swamp		80	142	2
		SubTotals	80	142	2
Woodland - Conifer - Wetland					
CSW	Conifer Swamp Woodland (spruce-mixed phase)		322	781	2

Map code	Map class name		Polygons	Area hectares	Average area hectares
WCS	Conifer Swamp Woodland (white cedar phase)		98	134	1
		SubTotals	*420*	*915*	*2*
Dwarf Shrubland - Evergreen - Upland					
CB	Crowberry - Bayberry Headland		4	14	4
		SubTotals	*4*	*14*	*4*
Dwarf Shrubland - Deciduous - Upland					
BBSS	Blueberry Bald - Summit Shrubland Complex		129	375	3
		SubTotals	*129*	*375*	*3*
Graminoid - Upland					
AM	Dune Grassland		1	1	1
		SubTotals	*1*	*1*	*1*
Sparse Vascular - Upland					
SVH	Open Headland - Beach Strand		255	372	1
SVT	Sparsely Vegetated Talus		12	11	1
		SubTotals	*267*	*383*	*1*
Shrubland - Deciduous - Wetland					
ASP	Alder Shrubland		146	162	1
SG	Sweetgale Mixed Shrub Fen		87	134	2
		SubTotals	*233*	*297*	*1*
Dwarf Shrubland - Evergreen - Wetland					
DSB	Dwarf Shrub Bog		6	93	15
FX	Fen Complex		169	476	3
		SubTotals	*175*	*569*	*3*
Graminoid - Wetland					
TG	Tidal Marsh		75	179	2
SMG	Graminoid Shallow Marsh		123	183	1
		SubTotals	*198*	*362*	*2*
Forb - Wetland					
OWM	Open Water - Deep Marsh Complex		71	131	2
		SubTotals	*71*	*131*	*2*
	Project Natural Vegetation Community Totals		***4,882***	***34,174***	***7***
Tidal Zone					
TZ	Tidal Algal Zone		411	2,744	7
TB	Tidal Beach		1	2	2
TM	Tidal Mud Flat		96	453	5
		SubTotals	*508*	*3,198*	*6*

Map code	Map class name		Polygons	Area hectares	Average area hectares
Small Island with Vegetation (map units of 0.1 - 0.5 ha)					
SIT	Small Island with Trees		54	10.0	0.2
SIS	Small Island with Shrubs		4	0.6	0.1
SIG	Small Island with Grass		4	0.7	0.2
SIR	Small Island with Rock		22	4.7	0.2
		SubTotals	*84*	*16.0*	*0.2*
Cultural Vegetation					
EPL	Evergeen Plantation		5	8	2
SMD	Mixed Deciduous Shrubland		251	726	3
MGF	Mixed Grass - Forb		208	369	2
PGCH	Perennial Grass Crops		166	481	3
PGCS	Perennial Grass Crops with Sparse Shrubs		3	4	1
		SubTotals	*633*	*1,587*	*3*
	All Vegetation Map Classes Totals		***6,107***	***38,976***	***6***
Non-vegetated Water					
WBP	Beaver Pond (non-vegetated)		4	3	1
WNP	Natural Pond (non-vegetated)		20	127	6
WST	Stream (non-vegetated)		1	0	0
WLK	Lake (non-vegetated)		9	930	103
WO	Ocean - Bay - Estuary (non-vegetated)		11	52,872	4,807
		SubTotals	*45*	*53,932*	*1,198*
Land Use					
UR	Residential		592	1,788	3
UC	Commercial and Services		82	384	5
UT	Transportation and Roads		29	123	4
UM	Mixed Urban or Built-up Land		71	1,027	14
UBL	Other Urban or Built-up Land		16	99	6
ARB	Other Agricultural Land		96	148	2
BLQ	Strip Mines, Quarries, and Gravel Pits		82	216	3
		SubTotals	*968*	*3,785*	*4*
	MAP DATA GRAND TOTALS		***7,120***	***96,693***	***14***
No Data					
ND	No Data		2	158,245	79,125
		SubTotals	*2*	*158,245*	*79,122*
	Map Data & No Data Totals		***7,122***	***254,938***	***36***

Recommendations for Future Projects

Acadia NP was one of the earlier parks to be mapped under USGS-NPS Vegetation Mapping Program, and great care went into designing this initial effort. As with any complex task, however, we learned some important lessons with this project. We offer our perspective and several suggestions we believe will benefit the program as it continues its complex task at efficiently (time and funds) and accurately documenting the vegetation patterns of the National Parks.

Sequential rather than parallel timing of products

In this effort, classifying and mapping of the vegetation proceeded on parallel rather than sequential tracks and vegetation types were redefined several times as the learning process proceeded. Ongoing mapping efforts lost efficiency, therefore, as effort needed to be directed toward ensuring maps created under earlier classification schemes where brought into compliance with the newest classification approach. From a mapping perspective, greatest accuracy and cost-effectiveness would result from developing the vegetation types from the vegetation samples prior to mapping. Whereas the goal is to shorten the overall duration of the project, we suggest it would be more efficient to stack different parks rather than to stack the steps of the process for a single park. We believe it would be better to have the mappers and ecologists work together on reconnaissance and the draft classification, but allow mapping itself to wait until the vegetation samples have been analyzed. This philosophy is partially reflected in the updated VMP documentation that regards the entire process as iterative between classifiers and mappers, yet puts an emphasis on classifying first with mappers lending support, then mapping with classifiers lending support.

Careful selection of the timing of aerial photography

Spring 1997 aerial photography was decided upon at the initial scoping meeting (March 1997) with the hope of jump-starting the mapping effort into the present year and, optimistically, expediting the entire mapping process. Unfortunately, we found the selection of spring photography lengthened the mapping process and adversely affected mapping accuracy for several major vegetation types.

At the time of the photography flight, not all the vegetation had reached peak biomass and some had not yet begun. This greatly affected our ability to interpret percent canopy cover or species composition. Deciduous forest types, for example, became difficult to distinguish from each other. The contrast between deciduous and conifer species also was limited and misinterpretation of vegetation communities easily occurred. One of Acadia's prominent management concerns involves wetlands, which, at the time of photography, were not fully expressed in terms of photo signatures. The timing of the photo mission, therefore, should be carefully considered in relation to the objectives of the project and management issues.

Better planning to ensure adequate field time and information exchange between ecologists and mappers

We believe the time mappers, classification staff, and managers are together in the field is one of the most critical steps towards creating a successful relation of meaningful map classes to vegetation types. Certainly, scheduling such time with such a diverse and busy group is difficult. However, we feel our initial time together in the field for the Acadia NP product was insufficient in duration. Consequently, time in the field was inadequate to discover and learn the vegetation types and discuss how they best be mapped.

More vegetation samples for classification development

Whereas the sampling protocol (The Nature Conservancy and Environmental Systems Research Institute 1994b) calls for an average of 10 plots per vegetation type, funding limited us to an average <4 plots per type. This sample size was sufficient for many plant types, but it was inadequate for variable ones. Since at the start of a mapping effort, the exact nature of variability is unknown, we believe it best to come as close to the recommended allocation of effort (10 plots) as is financially feasible. Alternatively, if historical data exist to generally define variability of types, sample allocation may perhaps be reduced or more effectively allocated.

Incorporate accuracy assessment data into vegetation descriptions

Much potentially useful vegetation data was collected through the accuracy assessment process. We believe such data can be valuable in refining the vegetation descriptions for especially variable types for which we had few initial samples (see previous paragraph).

Incorporate data into Biological and Conservation Database for statewide and larger perspective

The USGS-NPS Vegetation Mapping Program is an exceptional source of new information on the presence of rare or exemplary communities. We strongly support entering data from such projects into the Natural Heritage Program's Biological and Conservation Database (e.g., Maine Natural Areas Program). Not only does this make the information available within the NatureServe and Natural Heritage Network standard data formats, but it also allows a statewide perspective on their presence, which is essential in conservation planning. Unfortunately our initial scoping and budgeting did not acknowledge this need and we were able to only partially complete this task.

Implement enhanced protocols and training for accuracy assessment

Accuracy assessment is a lengthy, expensive, and necessary part of the mapping project. In this project, accuracy assessment was problematic because a large portion of the errors was "false" errors. (A false error is a mismatch between a polygon and an accuracy assessment call if the disagreement was caused by either a GPS error or an inclusion error.) "False" errors, if included in the accuracy assessment, would have resulted in accuracy below 70%. Many false errors could be avoided through better training of field crews. In addition, the point selection process could include "cost surfacing," saving time from having to manually eliminate inaccessible points. To ensure a smooth process and more accurate data, therefore, we suggest standardized field training methods be developed and implemented for the program. Standardization, we also suggest, should include an Arc Macro Language (AML) or other GIS application for site selection, field training methods, and data analysis.

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Appendix A

Example of an Observation Field Reconnaissance Form

Figure A-1. Reconnaissance field data sheet for photointerpretation mapping.

Appendix C

Example of an Accuracy Assessment Form

USGS-NPS Vegetation Mapping Program 333 — **ACCURACY ASSESSMENT FORM ACADIA NATIONAL PARK, 1999**

Plot #: WP 381 1327 | Park code: *ACAD* | Date: 99-08-19 | Observers: SCR JEW

Datum: NAD 83 | Accuracy: 4.2 | UTM Zone: *19*

UTM Easting 5 6 0 . 9 3 0 | UTM Northing 4 . 9 1 4 . 8 9 1

Offset from pt. Easting: ±0 m | Offset from pt. Northing: +1 m

SETTING

Topography: Slope = -35, +22%. Transitional rocky shrubland between bald + forest. Bedrock outcrops + surface deposits (not huge erratics though)

Elevation: 126 (m) OR ft | Aspect 240°

Soil texture: gravelly sand. | Soil depth: 20 cm | Stoniness: small stones (1.5cm) | Drainage: ex. well

Setting comments: Huge charcoal chunks. Soil full of charcoal.

STRUCTURE & COMPOSITION

stratum	Major Species Present	% evergreen:decid 0 : 100	% Cover of Layer	Cover Patchy or ~Uniform?
TREE	Bet pap		<5	P
SAPLING	Bet pap Bet pap Ame sp.		40	~U
SHRUB (1-3 m)	Bet pop		50	U
DWARF SHRUB	Vac ang Dic ton Ame sp. Ace rub		30	U
HERB	Dan spi* Sol rand, Ple aqu. Ory asp		10-15	~U
BRYOID	Pol pil, Clasyl Cla sp.		10	P

Indicator spp: —— | Rare spp: ——

VEGETATION TYPE and MAP UNIT

Veg. Type Code: ABW | Map Unit Code: SB

Alternate Veg Type: ABW | Alternate Map Unit: MDW

Veg Type #2 w/in 50 m of Pt.: ABW | Veg. Type #3 w/in 50 m of Pt.: BBSS

Rationale for Classification: Keys well. Downslope (i.e. Vegtype #2 w/in 50m) = more ABW/ABF This is SB.

Comments:

Figure C-1. Accuracy assessment field data form.

Appendix D

Ordination Diagrams and Results of the Vegetation Data Analysis

The following discussions and diagrams provide a detailed explanation of the analysis performed on vegetation sample data collected at Acadia National Park (NP; see Data Analysis section in Methods section). The purpose of the analysis is to elucidate vegetation patterns and vegetation types. The data from these analyses are built upon vegetation sampled at Acadia NP.

The results of the analyses are shown as ordination diagrams in Figures D-1–D-12, which may be unfamiliar to some readers. The diagrams plot samples according to their compositional similarity: samples close to each other are similar and those father apart less so. The data are first and second axis ordination scores for the samples. These axes reflect compositional gradients related to environmental factors; however, they are not direct scales of certain factors. Ordination diagrams are useful in two major ways. First, they give a graphical picture of the relations among groups of samples. Groups may be classes (forest, woodland, shrubland [e.g., Figure D-1]), hydrologic group (upland, wetland, etc. [e.g., Figure D-4]), or vegetation types (e.g., Figures D-5–D-8 and D-10–D-12). Second, one can overlay or correlate values of environmental factors to deduce influential environmental gradients (See Figure 7 in Field Sampling of Methods for example). If hydrologic regime shows a relation to the first axis, for example (Figure D-3), it is a more important determinant in vegetation composition than if it shows a relation only to the second or third axis, or none at all.

Preliminary Analyses

Vegetation was analyzed first with reference to physiognomic class and hydrologic regime. To see how vegetation differences corresponded to physiognomic class, we ran Detrended Correspondence Analysis (DCA) on forests, woodlands, and shrublands together. Wetland shrublands were strongly different from all other samples and the ordination was re-run without them. The two major gradients were forests and woodlands on the first axis (with considerable overlap), and uplands to wetlands on the second axis (Figures D-1 and D-2). The upland shrublands separated from the woodlands to some degree on the third axis, but it is apparent that physiognomic differences between woodlands and shrublands in Acadia do not translate into strong compositional differences. TWINSPAN of this same data set echoed these two gradients.

Looking at forests only, certain types, the "easy" ones, fell out clearly. Of the 12 forest types with more than one sample, six showed reasonably good separation in the ordination and the other six formed a largely undifferentiated mass in the center. Forest types that separated well included two wetland types, the closed expression of the Black Spruce Woodland Bog (CEGL006098) and the closed-canopy expression of the Northern White-cedar Wooded Fen (CEGL006507), and four upland types: Hemlock - Hardwood Forest (CEGL006129), Red Pine - White Pine Forest (CEGL006253), Northern Hardwood Forest (CEGL006252), and White Pine - Oak Forest (CEGL006293). The messy types, Sugar Maple - White Pine Forest (CEGL005005), Eastern Hemlock - White Pine - Red Spruce (CEGL006324), Maritime Spruce - Fir Forest (CEGL006151), Successional Spruce - Fir Forest (CEGL006505), Red Spruce - Hardwoods Forest (CEGL006267), and Red Maple - Conifer Acidic (CEGL006198), are those that are characterized by red spruce, balsam fir, and/or red maple. The wide ecological amplitudes of these three species can obscure differentiation of community types.

Woodland samples paralleled the forest samples. Detrended Correspondence Analysis separated half the types well, with the other half initially failing to separate. The first axis separated the boggy woodland types, Red Maple Swamp Woodland (CEGL006395) and Black Spruce Woodland Bog (CEGL006098), from the remainder. The second axis reflected a conifer to deciduous gradient. (It was also significantly correlated with introduced species, but only because of high values in one sample, a rather spurious relation). The third axis provided little additional information beyond separating out those woodlands with a strong white cedar component.

Woodland types that separated easily were those dominated by pitch pine or jack pine, black spruce or red maple bog woodlands, and white cedar woodlands. Those that remained, reflecting an indistinct identity within the full data set, were those with red spruce, red oak, or with both conifers and deciduous trees making up at least 25%. Within this group, the red spruce woodlands were at one end of the gradient and the mixed deciduous woodlands at the other end.

Samples dominated by dwarf shrubs or herbs segregated first by hydrology and saltwater influence. Salt marshes, dune, and beach vegetation pulled out strongly on the first axis (Figure D-3). Once those were removed, the strongest gradient remained the upland – wetland split, with class (shrub, dwarf shrub, herb) showing gradations but no clear separations between the three physiognomic types (Figure D-4).

Based on these preliminary analyses, the complete data set was divided into the following subsets for further refining the vegetation types:

- Upland forests and woodlands
- Wetland forests and woodlands
- Non-forested uplands
- Non-forested wetlands

Wetland shrublands were included in the non-forested data sets; upland shrublands were included in both forested and non-forested sets (because of overlap with both types), and then pulled out entirely. In some cases, we extracted smaller data sets to look at particular types.

By analyzing these smaller sets with better resolution, we assessed how the rough assignment of vegetation type, usually done in the field, corresponded to actual compositional differences. Our concept of vegetation types was evolving based on both field observations and photointerpretation, and these analyses were useful for identifying gross vegetational patterns and highlighting where the characteristics on which we discriminated vegetation types were not sufficiently refined to result in consistent assignment.

Dendrograms constructed from the TWINSPAN analyses, ordination diagrams coded by field vegetation type, and the summaries of each sample point provided the material for two important, and iterative, steps: determining which samples did not classify well or were misclassified, and determining what suite of structural characters and dominant species were most useful in segregating the vegetation types.

We then assigned each sample to a vegetation type based on these revised diagnostics, and re-ran DCA. These ordinations show the relations and overlap of the vegetation types as best as we can distinguish them with the available data. Indicator Species Analyses identified species that might be diagnostic in discriminating between closely related types.

All species found during the sampling effort are listed in Appendix H: Plant Species List of Acadia National Park.
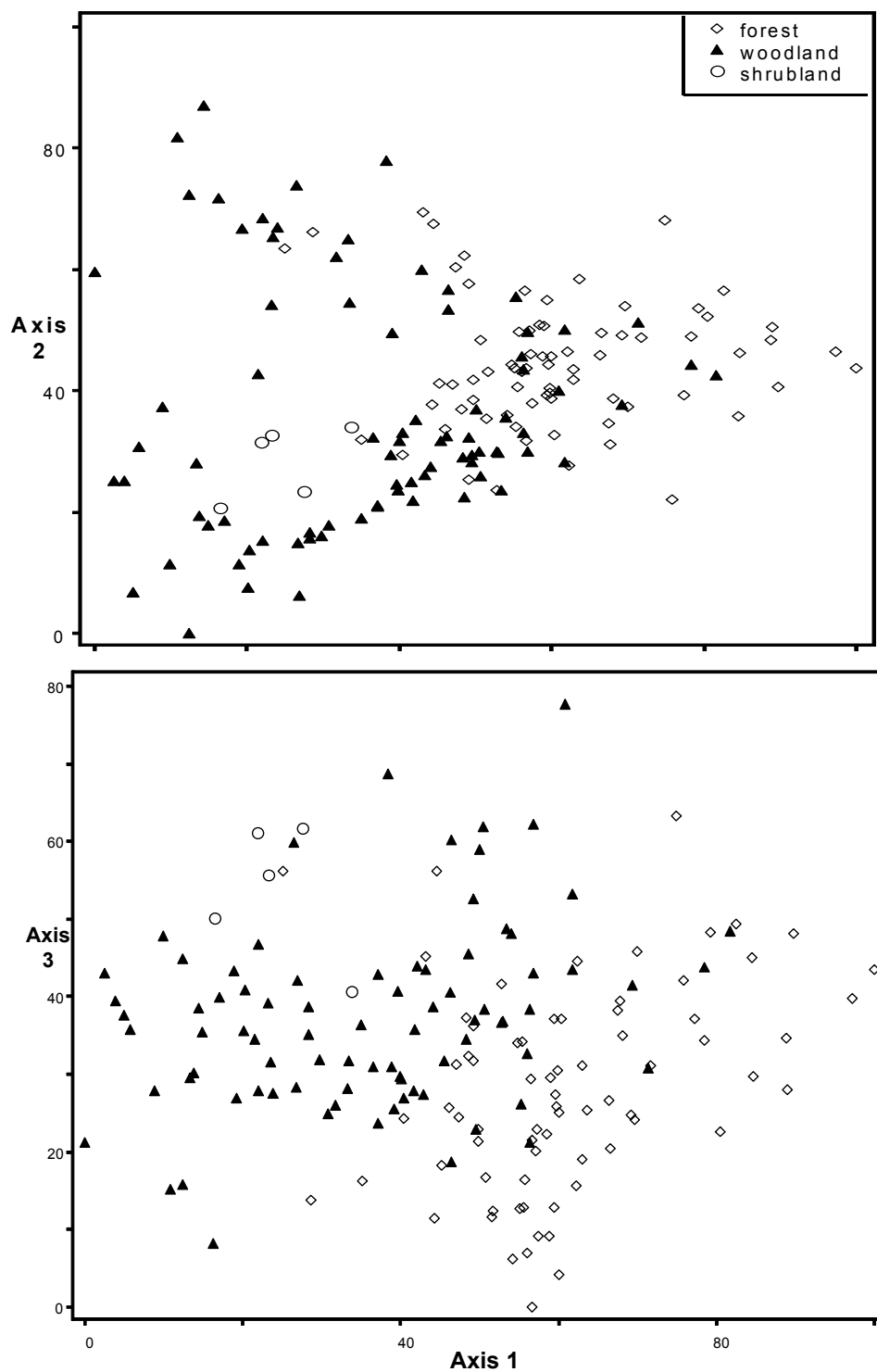
Figure D-1. Detrended Correspondence Analysis ordination of all forests, woodlands, and upland shrublands, by vegetation class. The first axis is plotted against the second axis (top figure) and the third axis (bottom figure). These axes accounted for 38% of the variance in the data. Axes are scaled to percent of the maximum score on axis 1.
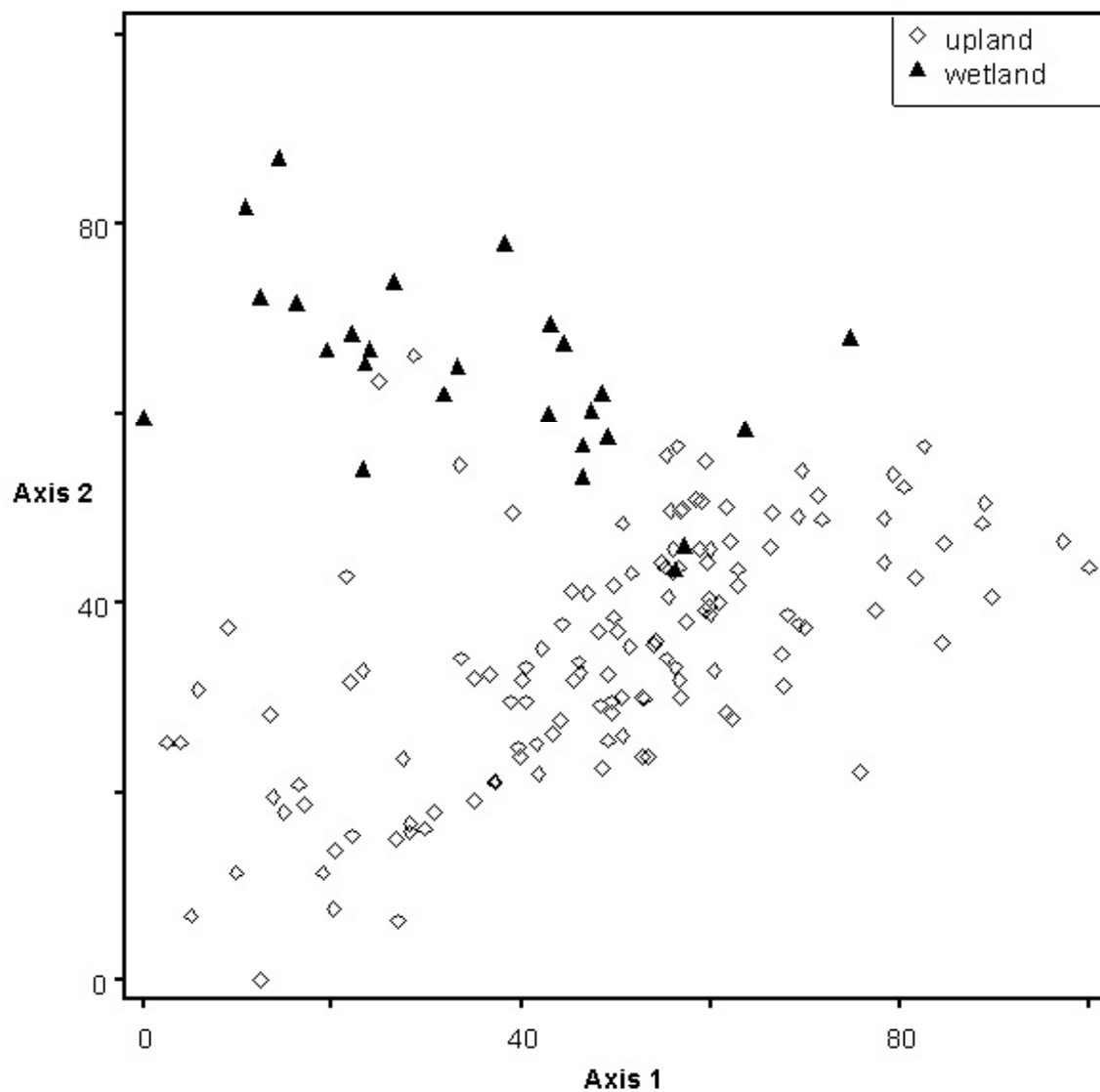
Figure D-2. Detrended Correspondence Analysis ordination of all forests, woodlands, and upland shrublands, plotted by hydrologic regime. Note the strong separation of wetland samples on the second axis. Axes are scaled to percent of the maximum score on axis 1.
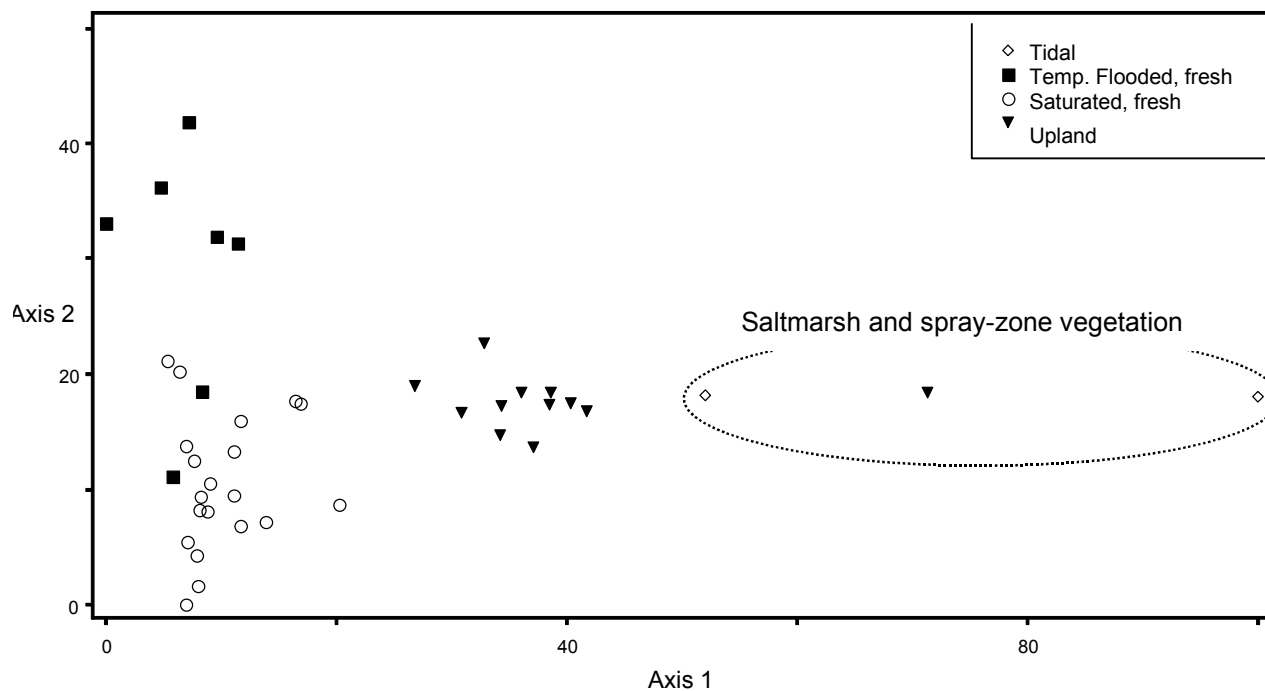
Figure D-3. Non-forested vegetation showing the strong influence of salt-spray vegetation types (removed for subsequent analysis). Axes are scaled to percent of the maximum score on axis 1.
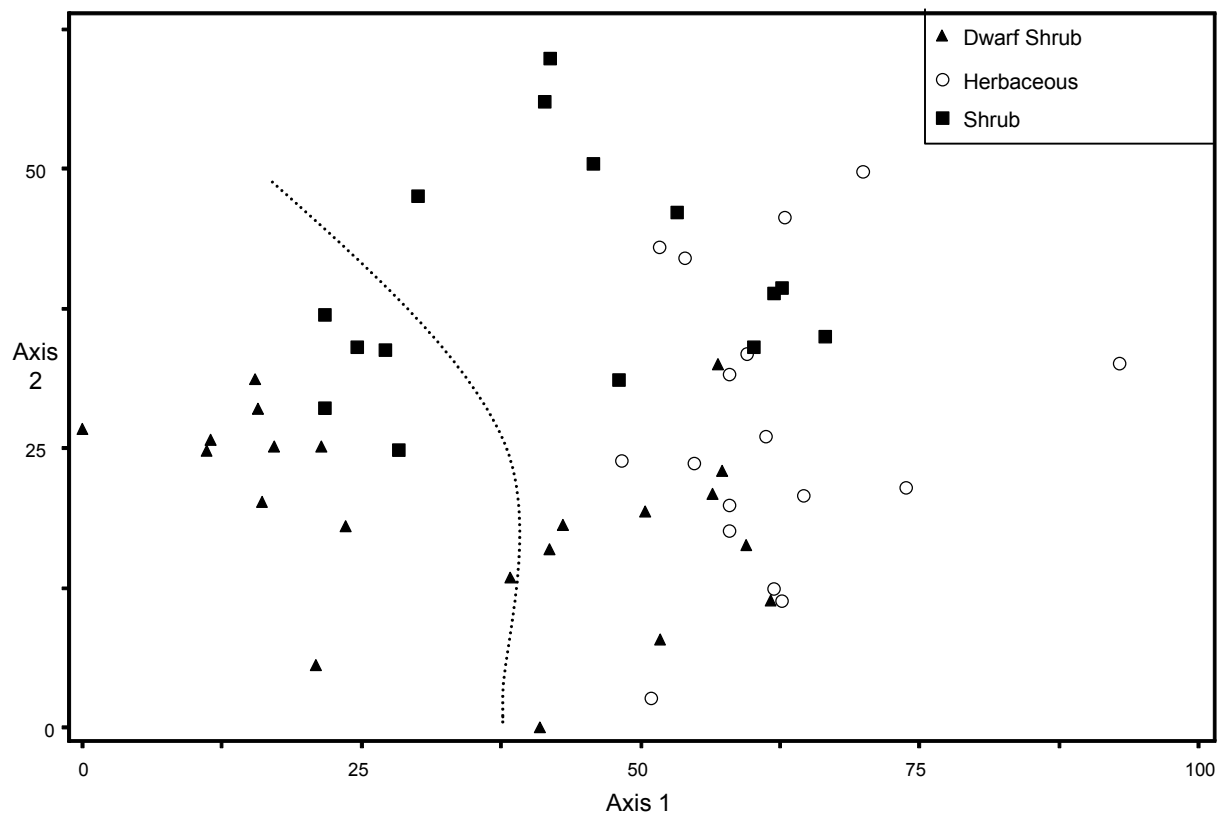
Figure D-4. Non-forested vegetation by physiognomic class. Note upland to wetland gradient on Axis 1: points to the left of the dashed line are upland. Axes are scaled to percent of the maximum score. R2 for the first three axes = .382. Axes are scaled to percent of the maximum score on axis 1.

Upland Forests and Woodlands

Twenty-three types of upland forests and woodlands are defined for Acadia. Analysis of the 133 samples showed the primary gradient (first axis) to be a forest-woodland transition (Figure D-6), with an element of nutrient status. Northern hardwood forests are at the left end of the axis, followed by spruce/fir and oak forests, then by oak, spruce or mixed pine woodlands, then by the most nutrient poor pitch pine / jack pine / black spruce woodlands (see Figures D-7 and D-8). Superimposed on the forest-to-woodland gradient is a deciduous-to-coniferous gradient, with deciduous forests and woodlands in the upper left quadrant of the ordination diagram, grading to coniferous samples in the lower right (Figure D-6).

The environmental and vegetation summary variables' correlations with the DCA axes mirrored forest-to-woodland and deciduous-to-coniferous gradients. First axis scores were positively correlated with the percent of conifer cover in the canopy and with the total cover of dwarf shrubs, herbs, and bryoids (i.e., cover of the lower layers increases as one moves from forest to woodland). The axis was negatively correlated with the total canopy percent, total basal area, number of canopy species, and number of herbaceous species. The second axis was positively correlated with both cover and richness of herbs and dwarf shrubs, and negatively correlated with canopy conifer percentage, basal area, canopy closure, and bryoid cover.

TWINSPAN of these data showed a clear separation (1st split; Figures D-7 and D-8) into forests and oak woodlands versus spruce/pine woodlands, with the spruce/pine woodlands characterized by *Kalmia angustifolia*, *Vaccinium angustifolium*, and *Gaylussacia baccata*. A few types in the middle of the ordination diagram, Early Successional Woodland/Forest (CEGL006303), White Pine - Oak Acid Bedrock Glade (CEGL005101), White-cedar Woodland (CEGL006411), Eastern Hemlock - White Pine - Red Spruce (CEGL006324), and Red Pine - White Pine Forest (CEGL006253), were divided by this first split. (A characteristic of TWINSPAN is that groups in the middle—the area of least definition-- can get split "artificially" in an early iteration.) In the case of the woodland types, Early Successional Woodland/Forest (CEGL006303) and White Pine - Oak Acid Bedrock Glade (CEGL005101), the split relates to their rather broad amplitude in canopy closure and overall character: both can range from almost-closed-canopy forests to quite open woodlands, with associated understory variation. In the case of the white pine forest types, Red Pine - White Pine Forest (CEGL006253) and Eastern Hemlock - White Pine - Red Spruce (CEGL006324), and the White-cedar Woodland (CEGL006411) type, the same forest-woodland gradation may be a factor, but these are also types that are not well represented in Acadia and thus with few samples (N=3 for each).

The first TWINSPAN split also reveals how the forest-to-woodland distinction relates both to canopy closure and the development of understory vegetation. When samples dominated by red spruce were assigned to forest or woodland type based only on the canopy closure, the "woodland" (< 70% canopy) samples were divided by the first TWINSPAN split; but when the < 70% canopy samples without the heath shrub layer were put back with the Maritime Spruce - Fir Forest (CEGL006151) type, the split was clean (Figure D-7). This supports the field observations that whether an area is best typed as "forest" or "woodland" depends both on the dwarf shrub and herb layer development as well as canopy closure.

The difficulties in separating some forests and woodlands vegetationally are consistent with difficulties in separating them during photointerpretation. Acadia is characterized by a full suite of forest-to-woodland gradations, and it is not always obvious to which class a particular type should be assigned. For example, Cedar Seepage Slope (CEGL006508) and White-cedar Woodland (CEGL006411) types exhibit both forest and woodland characters: variable canopy closure, and sometimes but not always a well-developed understory; and the DCA showed them to have the greatest overlap with the forested types of any woodland types (Figure D-8). Similarly, two of the three samples for the Red Pine - White Pine Forest

(CEGL006253) type appear on the "woodland" side of the ordination diagram, and this forest type does have characters intermediate between forest and woodland.

TWINSPAN produced four major groups of forest types, plotted onto the DCA diagram in Figure D-7. Group "A", with the largest number of samples, are the spruce-fir forests. The three major components of this group are the Maritime Spruce - Fir Forest (CEGL006151) type and two variants of it. The Successional Spruce - Fir Forest (CEGL006505) type is an earlier successional version of the Maritime Spruce - Fir Forest (CEGL006151) type, and is common in the portion of the park that burned in 1947. The Eastern Hemlock - White Pine - Red Spruce (CEGL006324) type is similar to the spruce-fir stands but with a white pine supercanopy component. Group "B" are samples intermediate between heavily coniferous spruce-fir and heavily deciduous northern hardwoods. This includes the Red Spruce - Hardwoods Forest (CEGL006267) type, two of the three samples of the Hemlock - Hardwood Forest (CEGL006129) type, and those of the Northern Hardwood Forest (CEGL006252) type that have 5-20% of the canopy made up of spruce and/or fir. Group "C" is primarily beech-birch-maple forests without spruce and fir, but also includes the third sample of the Hemlock - Hardwood Forest (CEGL006129) type. Group "D", the "oak" group, has the largest range of variation of the four groups, and includes both forests and deciduous-to-mixed woodlands. Types that fall here are most of the Early Successional Woodland/Forest (CEGL006303) type and all of the red oak types: White Pine - Oak Forest (CEGL006293), Successional Oak - Pine Forest (CEGL006506), Central Appalachian High-Elevation Red Oak Woodland, Northern Variant (CEGL006134), and White Pine - Oak Acid Bedrock Glade (CEGL005101).

On the other side of the first TWINSPAN division, four groups of conifer woodlands can be identified (Figure D-8). Group "A", Jack Pine Heath Barren (CEGL006041) type and most of the CEGL006041 (CEGL006292) type are those in the most low-nutrient and cool microclimate habitats, Acadia's closest approach to boreal conditions. The other groups are more temperate in character. Group "B" are woodlands mostly featuring red spruce, including the Spruce - Fir Rocky Summit (CEGL006053) type, the Red Spruce Talus Slope Woodland (CEGL006250), two of the three samples of Red Pine - White Pine Forest (CEGL006253) type, and the two samples of the Pitch Pine / Blueberry spp. - Huckleberry Woodland (CEGL005046) type. Groups "C" and "D" are characterized by pitch pine. The wide amplitude of pitch pine woodlands on the first axis, resulting in this split into two groups, reflects the extensive development of this type in Acadia. Pitch pine woodlands range from those more closely allied with oak-pine woodlands (Group "C") to those in more extreme habitats that show similarities to the black spruce or jack pine types. The one sample of the Coastal Pitch Pine Outcrop Woodland (CEGL006154) type, a type known from only one location in Acadia, is at the extreme right end of the pitch pine woodland range of variation, and occurs on a foggy and cool headland on the immediate coast. (Pitch pine - Corema woodlands elsewhere in the state occur in more temperate settings as well, and are not considered vegetationally distinct from straight pitch pine woodlands in the state classification.)

A description of each upland forest and woodland type is given in Appendix I: Vegetation Descriptions of this report.
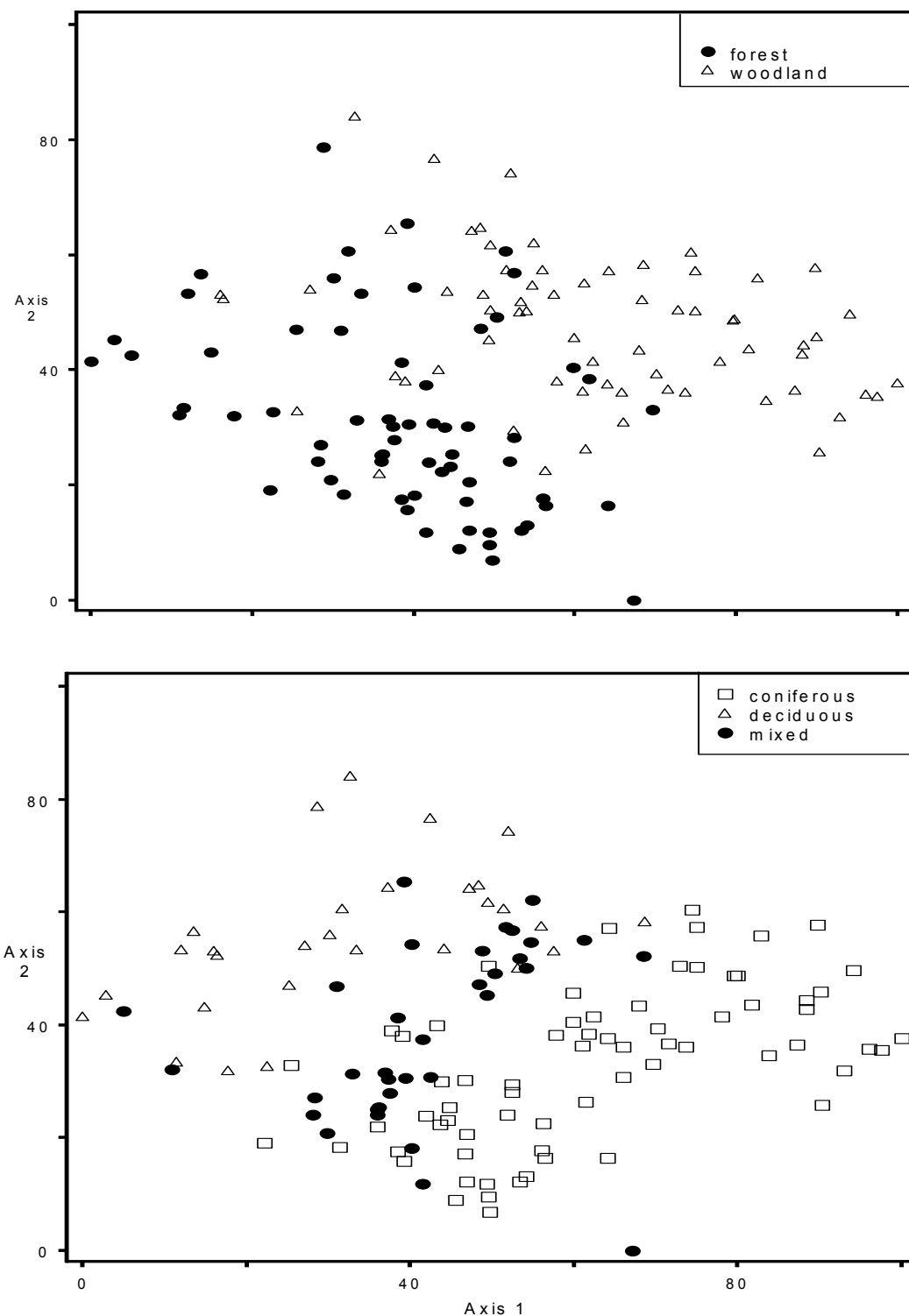
Figure D-6. Upland forests and woodlands by class and subclass, showing gradients on both axes from forest to woodland and from deciduous to coniferous. Axes are scaled to the percent of the maximum score on axis 1.
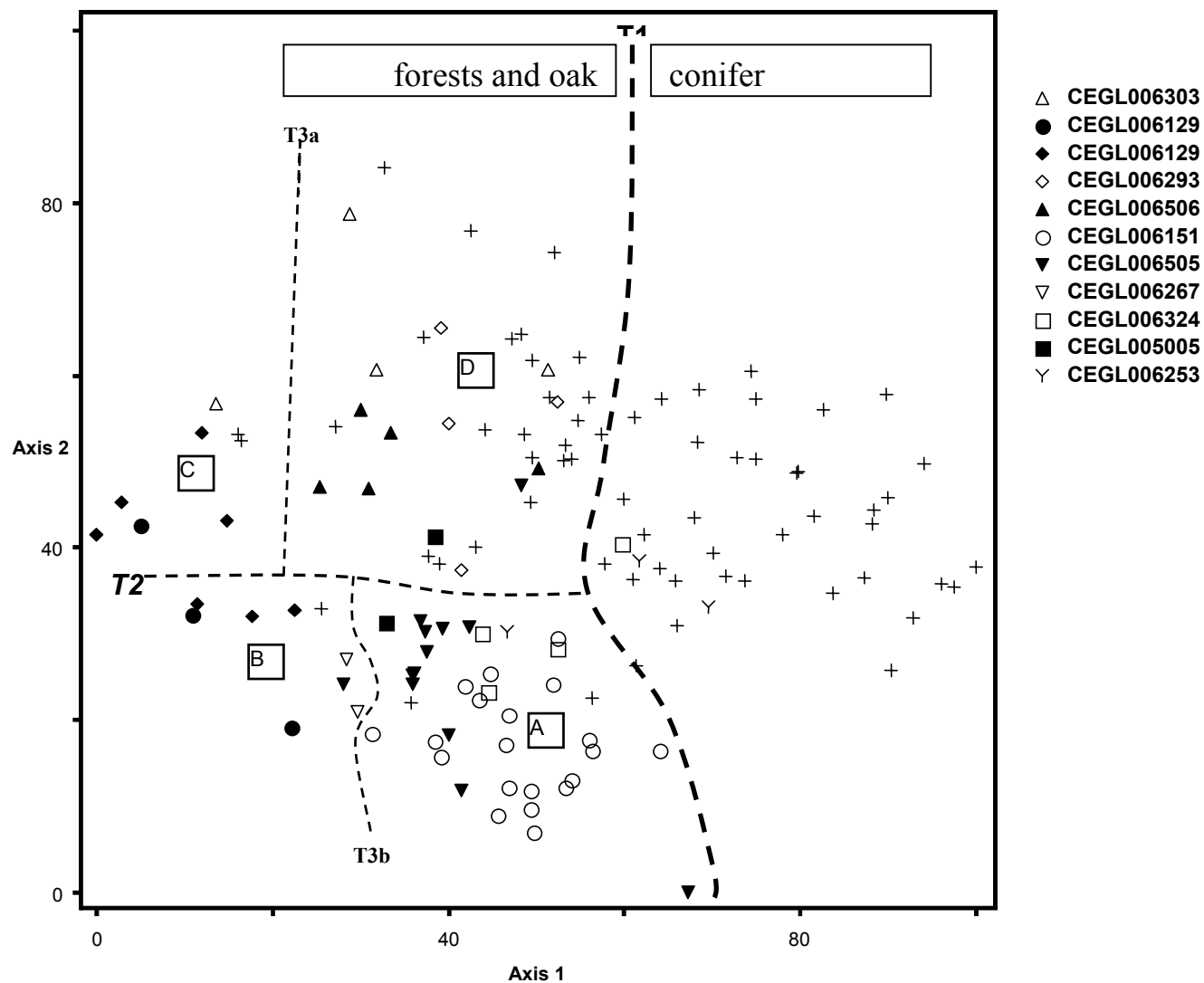
Figure D-7. Detrended Correspondence Analysis ordination of upland forest and woodland samples, coded by forest type. Twinspan divisions are shown as heavier to lighter lines; "T1" refers to the first Twinspan division, etc. (Divisions on the "conifer woodland" side of the first division are shown in Figure D-11.) Woodland types are included for reference and marked with a cross; Figure D-11 shows those by type. Boxed letters A-D refer to groups discussed in the text. Axes are scaled to percent of the maximum score on axis 1.
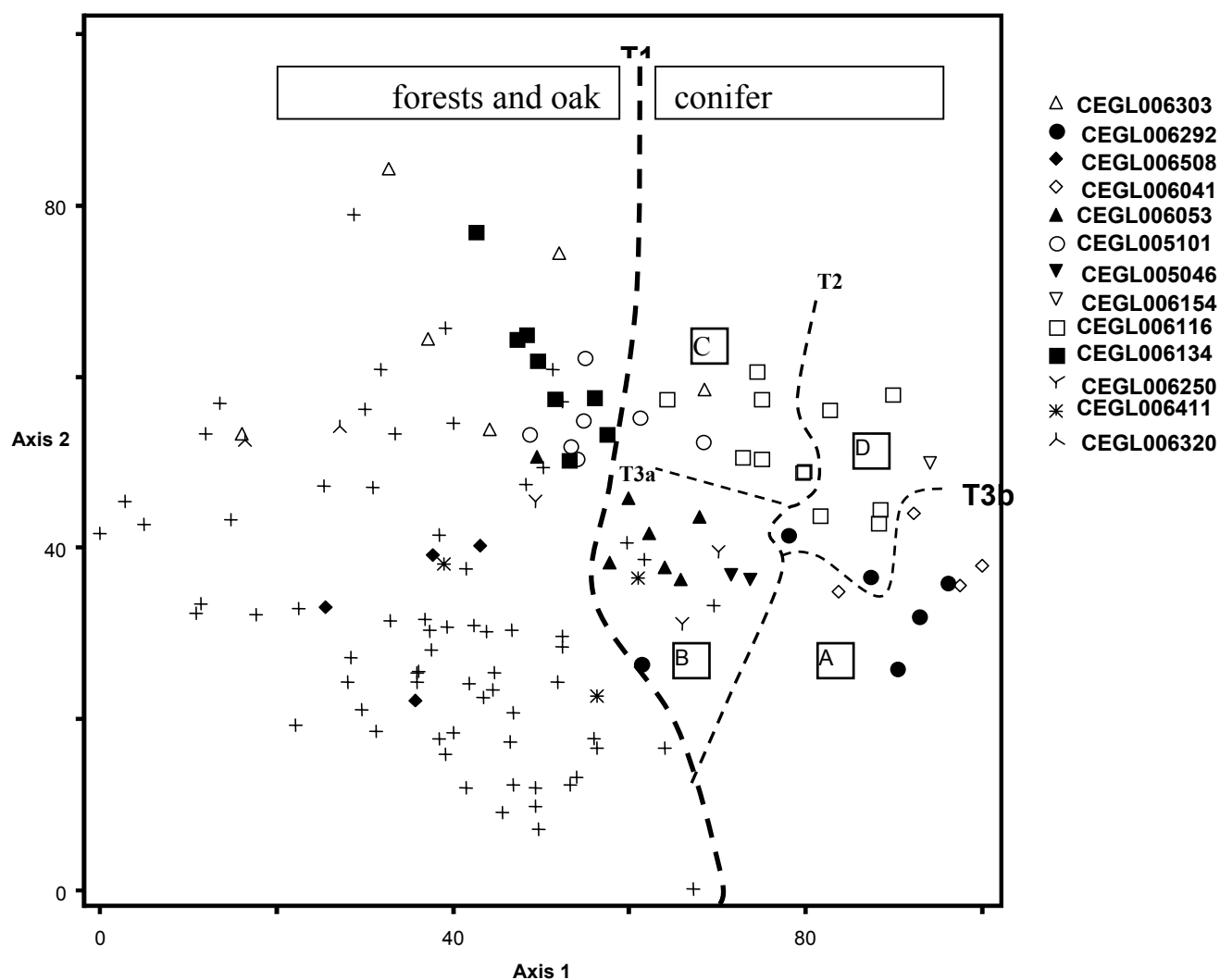
Figure D-8. Detrended Correspondence Analysis ordination of upland forest and woodland samples, coded by woodland type. Twinspan divisions are shown as heavier to lighter lines; "T1" refers to the first Twinspan division, etc. (Divisions on the "forest" side of the first division are shown in Figure D-10.) Forest samples are marked with a cross. Boxed letters A-D refer to groups discussed in the text. Axes are scaled to percent of the maximum score on axis 1.

Wetland Forests and Woodlands

Five types of wetland forests and woodlands were differentiated, with one type, the Red Maple Swamp Woodland (CEGL006395), subdivided into a deciduous phase and a mixed phase. Detrended Correspondence Analysis ordination of the 26 samples revealed a first axis gradient related to nutrient availability and substrate (Figure D-9): boggy samples at the left end, and mineral soil wetlands with few bryophytes and somewhat higher pH at the right. The second axis showed a strong coniferous to deciduous gradient. The species plot of these data placed the heath shrubs conspicuously in the lower left corner (boggy samples), corresponding with the most acidic and nutrient poor conditions where black spruce dominates.

Figure D-9 demonstrates the continuous gradation from one type to another; intermediates among types, especially the peatland types Black Spruce Woodland Bog (CEGL006098), Northern White-cedar Wooded Fen (CEGL006507), and Red Maple Swamp Woodland (CEGL006395), are common. Northern white cedar, in particular, displays the wide amplitude seen also in the upland samples. Northern white cedar wetlands range from those closely allied with black spruce bog woodlands, to typical cedar fens, to those in a more minerotrophic setting with red spruce.

Woodlands dominated by red maple are mapped as only one type but separated in both DCA and TWINSPAN analyses. Those with strong dominance of red maple tend to be in higher nutrient conditions and may be on either shallow peat or mineral soil. On the islands, the red maple woodlands have a strong black spruce component (technically mixed), and a more nutrient-limited character. In analyses of statewide vegetation patterns, red maple woodland fens likewise grade from all deciduous canopies to those mixed with black spruce or larch, although red maple is always the most abundant tree. Red maple wetlands on mineral soils are a different type statewide; the closest ally in Acadia are the Red Maple - Conifer Acidic Swamp (CEGL006198) type along fairly small drainages.

A description of each wetland forest and woodland type is given in Appendix I: Vegetation Descriptions of this report.
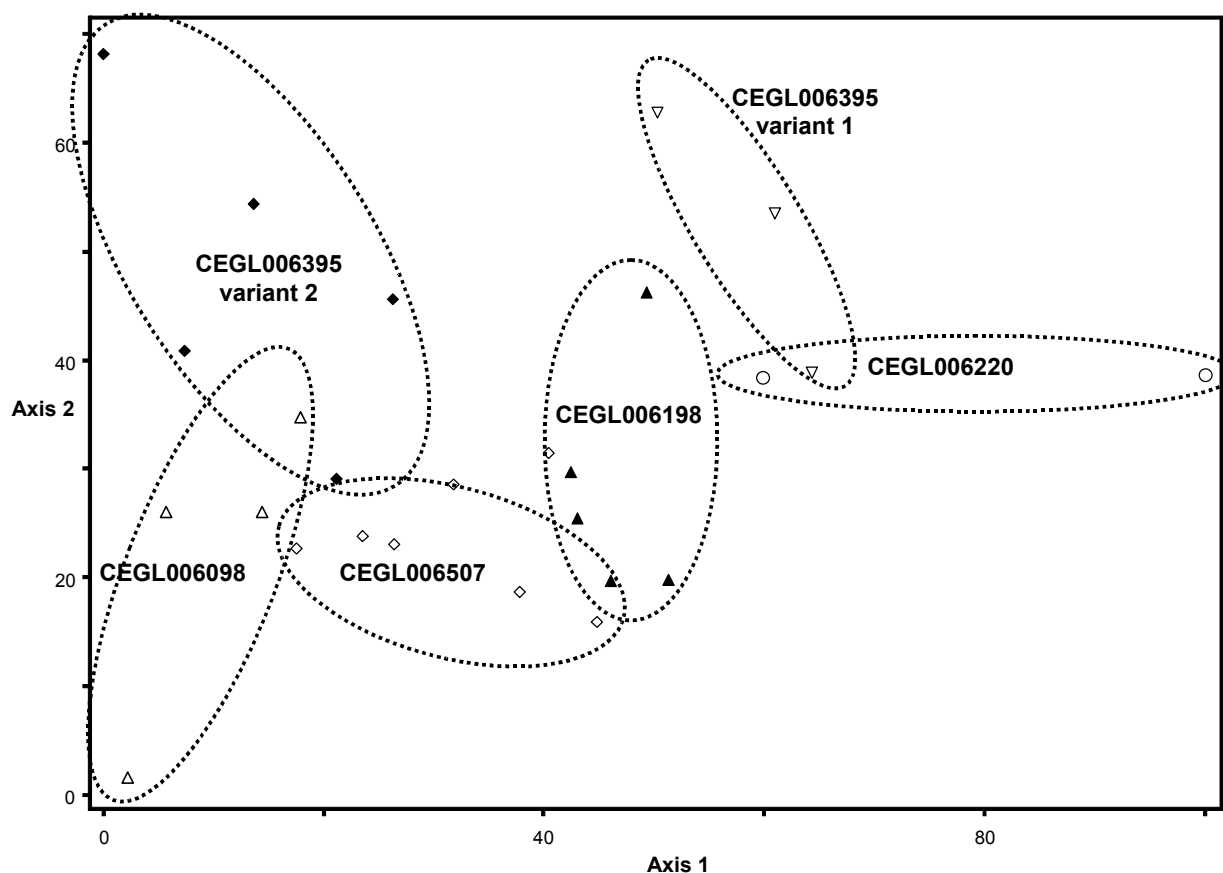
Figure D-9. Detrended Correspondence Analysis ordination of wetland forests and woodland samples, coded by vegetation type. Note that one of the CEGL006507 (Northern White-cedar Wooded Fen) samples falls into the CEGL006198 (Red Maple - Conifer Acidic Swamp) oval rather than the CEGL006507 oval. CEGL006395 variant 1 is the deciduous phase of CEGL006395 (Red Maple Swamp Woodland); CEGL006395 variant 2 is the mixed phase (see text). R2 for the first three axes = .625. Axes are scaled to the percent of the maximum score on axis 1.

Non-forested Uplands

Whereas Acadia is known for its bald summits, non-forested uplands are generally scarce in heavily forested Maine. Six non-forested upland vegetation types were distinguished for Acadia. Detrended Correspondence Analysis ordination of the samples showed the types to divide up fairly neatly, albeit with too few samples for most of the types (Figure D-10). In some cases the low sample numbers are due to natural scarcity of these types in Acadia.

Near the immediate shore, Northern Beachgrass Dune (CEGL006274) and Northern Maritime Rocky Headlands (CEGL006529) are distinctive as herbaceous-dominated types whose composition reflects the constant exposure to salt. The only dune grassland documented in Acadia is at Sand Beach, and this shows the typical dune grassland composition of Ammophila breviligulata dominance. Northern Maritime Rocky Headlands (CEGL006529) is a distinctive coastal type in which the sparse vegetation includes species with floristic alliances to subarctic coastal environments: Rhodalia rosea, Iris setosa var. canadensis, etc. This vegetation extends east from Acadia along the Maine and Canadian Maritime coastline, but Acadia represents its westernmost extent.

Most of the upland vegetation samples fall into the summit complex vegetation (lower left corner of Figure D-10), where the shrub form of the Early Successional Woodland/Forest (CEGL006303) grades into mixed summit shrublands and sparsely vegetated areas of blueberry and three-toothed cinquefoil (together typed as Blueberry Granite Barrens (CEGL005094), but variable). This complex of vegetation includes areas of low sparse vegetation with blueberry, herbs, and lichens, areas of taller (>1 m) non-heath shrubs with scattered spruce, and intermediate areas with huckleberry and other heaths (0.5 – 1 m tall) dotted with low spruce. These three subtypes often form mosaics on summits with extensive open areas.

The remaining open upland type, Crowberry - Bayberry Maritime Shrubland (CEGL006510), combines characteristics of dwarf shrubland vegetation with those of spray-zone vegetation. Like the open summit vegetation, it has a strong dwarf shrub component and features three-toothed cinquefoil, but the prominence of Myrica pensylvanica reveals its near-coastal location. Like the Northern Maritime Rocky Headlands (CEGL006529) type, this is typical of extreme coastal environments from Mount Desert Island east into the Canadian maritimes.

A description of each upland non-forested type is given in Appendix I: Vegetation Descriptions of this report.

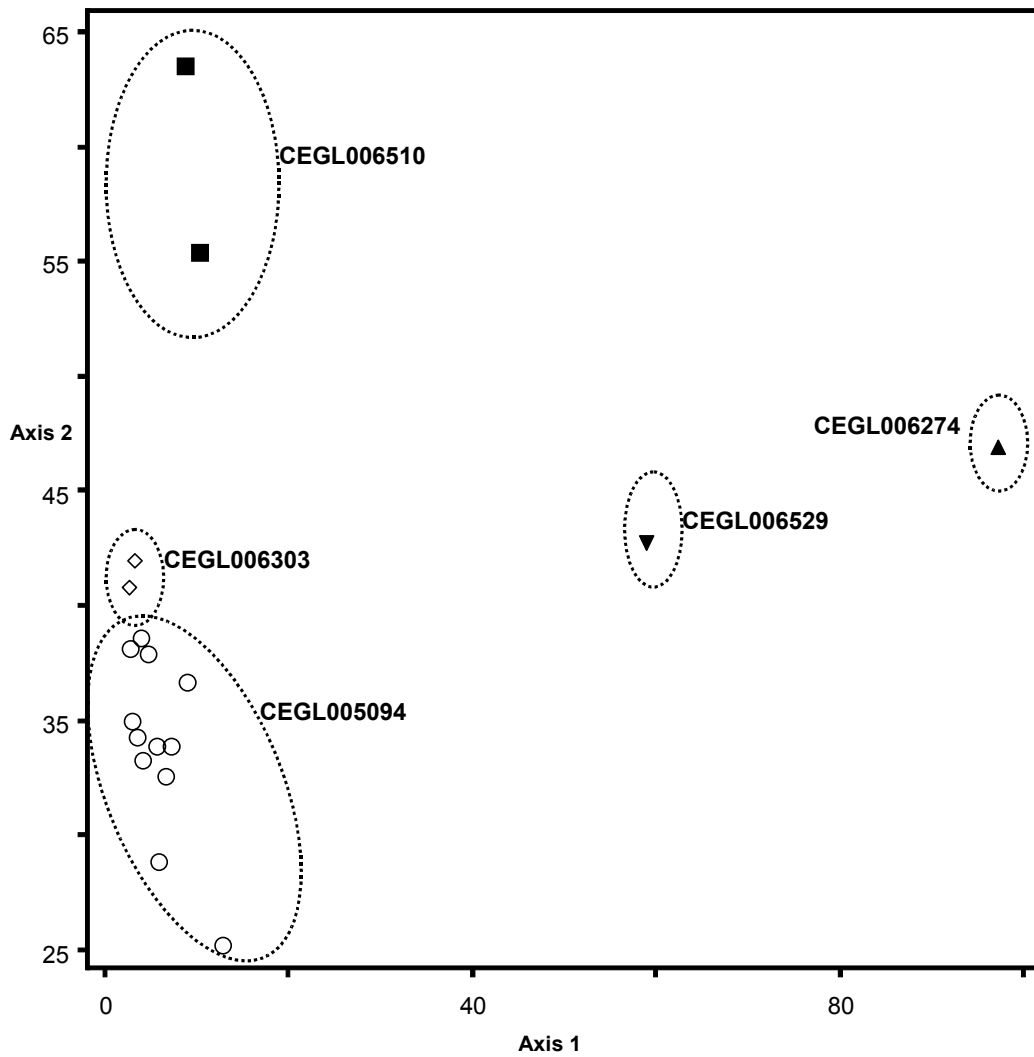**Figure D-10.** Upland non-forested vegetation types. The CEGL006303 (Early Successional Woodland/Forest) samples are the two shrubland samples of that physiognomically variable type. Two types, CEGL006106 (Sea-rocket - Oysterleaf Sparse Vegetation) and CEGL006534 (Northern Lichen Talus Barrens had no samples. Axes are scaled to percent of the maximum score on axis 1. R2 for the first three axes = .877.

Non-forested Wetlands

Non-forested wetlands in Acadia include a full array of peatland to marsh to open water wetlands, from freshwater to brackish and saline marshes. Open water marshes (i.e., those that lack persistent emergent vegetation, and these appear as open water on the May aerial photos, but support aquatic plant associations during the growing season) were not sampled; saltmarshes and brackish habitats were minimally sampled (N=2). Of the 19 vegetation types distinguished, we had samples for 13 of those (N=39); however, 9 of those 13 types had 3 or fewer samples. In some cases, this was due to natural scarcity (e.g., Bayonet Rush Herbaceous Vegetation [CEGL006345] type); in others, to lack of sufficient sampling effort (e.g., saline and brackish marshes). The two saltmarsh samples were omitted from the DCA because their marked differences from freshwater wetlands obscured the variation in the latter.

DCA of the 37 non-forested freshwater wetland samples revealed a gradient on the first axis running from dwarf-shrub dominated ombrotrophic peatlands through mineral soil graminoid-shrub marshes, to tall shrub alder wetlands, reflecting elements of nutrient availability, hydrologic regime, and substrate type (Figure D-11). The second axis was dominated by the strongly different Juncus militaris drawdown wetlands, clearly different from all of the other graminoid shallow marsh types (at least based on the two samples of this naturally scarce type).

The mineral-soil wetland samples segregated reasonably well into vegetation types, except for the two alder-dominated shrub wetland types, the Northern Peatland Shrub Swamp (CEGL006158) and the Alluvial Alder Thicket (CEGL006062), which were vegetationally indistinguishable with the 5 samples analyzed. Certain vegetation types are intermediate between clearly mineral-soil wetlands and clearly peatlands. The Eastern Tussock Sedge Meadow (CEGL006412) and the Sweetgale Mixed Shrub Swamp (CEGL006512) types can occur on either organic substrates, or on mineral substrates with a relatively thin organic layer on top. These transitional types fall in the middle of the first ordination axis.

Differences among the various bog and fen (organic soil) vegetation types were expressed on the third axis, after the more dramatic vegetation differences accounted for on the first two axes. The two apparent major gradients here are from ombrotrophy to minerotrophy on the first axis, and from graminoid dominance to dwarf-shrub dominance on the third axis (Figure D-12). The two types with the strongest affinity to near-coastal environments, the Maritime Crowberry Bog (CEGL006248) and the Maritime Peatland Sedge Lawn (CEGL006260), appear at the left side of the ordination diagram, with the other low-nutrient type, Northern Dwarf-shrub Bog (CEGL006225), at the top of the diagram. With more samples, one would likely see overlaps between these types as are seen between the other types in Figure D-12. The four fen vegetation types, Few-seeded Sedge - Leatherleaf Fen (CEGL006524), Leatherleaf Acidic Fen (CEGL006513), Slender Sedge Fen (CEGL006521), and Sweetgale Mixed Shrub Swamp (CEGL006512), show overlap as expected, but all but Slender Sedge Fen (CEGL006521) at least show sufficient separation to support the differences between the concepts for each type. The three Slender Sedge Fen (CEGL006521) samples span the gradient from Few-seeded Sedge - Leatherleaf Fen (CEGL006524) to Sweetgale Mixed Shrub Swamp (CEGL006512) types; however, the Slender Sedge Fen (CEGL006521) type is not well represented in Acadia, and analyses of samples statewide indicate that this is indeed a reasonably well-defined type (Anderson and Davis 1997, Gawler 1998).

A description of each non-forested wetland type is given in Appendix I: Vegetation Descriptions of this report.
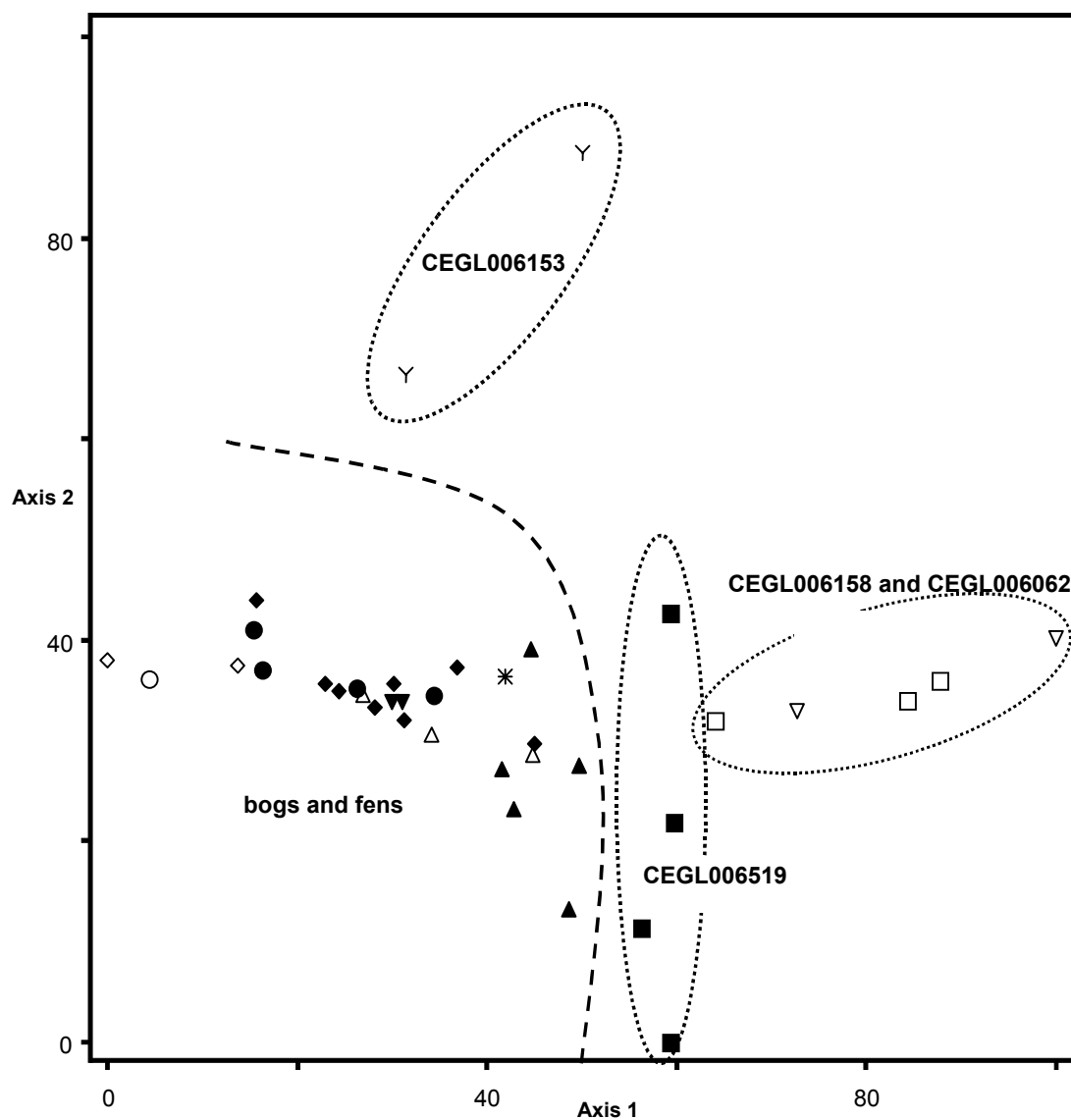
Figure D-11. Non-forested wetland vegetation, excluding saltmarshes: general patterns, with different symbols for different vegetation types. Dashed line separates bogs and fens from mineral-soil wetlands, which are labeled by type. See Figure D-12 for better resolution of bog and fen types. Axes are scaled to percent of the maximum score on axis 1. R2 for the first three axes = .504.
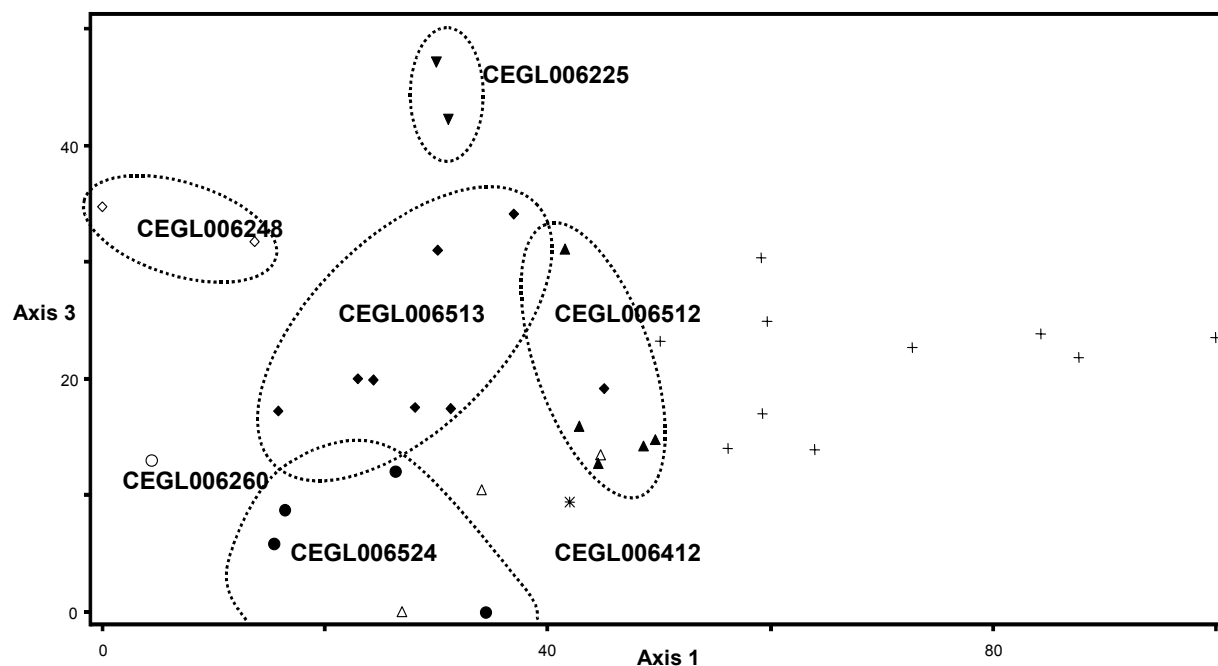
Figure D-12. Axes 1 and 3 of non-forested wetland vegetation ordination (see Figure D-11), showing bog and fen vegetation patterns. Symbols represent different vegetation types, labeled. "+" are mineral-soil wetland samples; see Figure D-11 for those vegetation types. Open triangles are the three CEGL006521 (Slender Sedge Fen) vegetation samples that overlap with CEGL006524 (Few-seeded Sedge - Leatherleaf Fen)and CEGL006512 (Sweetgale Mixed Shrub Swamp)types; also note one CEGL006513 (Leatherleaf Acidic Fen)sample in the CEGL006512 (Sweetgale Mixed Shrub Swamp)oval. CEGL006260 (Maritime Peatland Sedge Lawn) and CEGL006412 (Eastern Tussock Sedge Meadow) types had only one sample each. Axes are scaled to percent of the maximum score on axis 1.

Appendix E

Vegetation Classification Matrix

(National Vegetation Classification System Vegetation Communities –
Vegetation Map Classes)

How to use the Vegetation Classification Matrix

In the electronic version, the classification matrix is a separate spreadsheet. The matrix is designed to show the relations between the National Vegetation Classification System association types (vegetation communities) as per NatureServe (2003) and the map classes used in the Acadia National Park vegetation mapping project. The associations are listed in rows and the map class codes are listed in columns. A key to the map class codes is listed to the right of the matrix.

Blue squares signified with an "x" indicate a match or link between associations and map classes. In most instances, there is one blue square where a map class links to an association, signifying a one-to-one relation between a given map class and its corresponding vegetation association.

Some map classes have more than one blue square in their columns. This means that map classes sometimes include more than one association. For example, map class White Pine - Mixed Conifer Forest (WPC) includes two associations: the Eastern Hemlock - White Pine - Red Spruce Forest and the Hemlock - Hardwood Forest associations.

Likewise, some associations have more than one blue square in their rows. This means that some associations are mapped in more than one map class. For example, the Eastern Cattail Marsh association is mapped with two map classes: the Graminoid Shallow Marsh (SMG) and the Open Water - Deep Marsh Complex (OWM).

The numbers at the left of each row (listing the vegetation association) signify the frequency of shared occurances of the vegetation type with other map classes. Likewise, the numbers at the top of each column (listing the map class) signify the frequency of shared occurances of map class of that column with other vegetation types.

A key to map class names is on the right side of the matrix table.

Appendix F

Introduction

Purpose

This document provides descriptions of map classes used for the Acadia National Park Vegetation Mapping Project. Its purpose is to
- Provide a ground photo image for vegetated map classes,
- Describe each map class from a photointerpretation perspective so that the user may better understand how and why the map coverage was created,
- Describe the link between each map class and the vegetation communities of the National Vegetation Classification System (NVCS),
- Provide an area report for each map class, and
- Provide accuracy assessment results for each map class.

Organization

This document presents descriptions and ground photos of map classes used in the Acadia National Park Vegetation Mapping Project. Map classes that represent a NVCS natural/semi-natural vegetation type(s) are each presented in a uniform format covering one or two pages. Each map class description has the name of the map class and at least one representative ground photo. We discuss the map class from a photointerpreter's perspective, and describe the link between the map class and the vegetation type(s) within the NVCS. We describe map classes that represent cultural types (of NVCS), land use situations, and park specific elements more collectively within their groups.

For each map class representing NVCS types, we provide an area report as per the project's vegetation map describing polygon frequency, area in hectares, and average polygon size (in hectares). The full version of the area report can be found in the main section of the project report. At the bottom of each description, we provide results from the project's accuracy assessment. We report results for producers' and users' accuracy and the confidence intervals, along with detailed information on the types of errors that occurred. The accuracy assessment contingency table can be found in Appendix G: Accuracy Assessment Contingency Matrix.

The map class descriptions are arranged according to physiognomic and hydrologic categories, land use and land cover, and park specific groups. To save space in the report and for readability, the map class codes are used throughout the descriptions. Map class names and codes are found below in Table F-1.

Map Classes and Photointerpretation Mapping

Photointerpretation is discussed in the main report. However, it might be worth reiterating portions of that discussion here. We performed photointerpretation using spring 1997 color infrared (CIR) film transparencies. Ground features were interpreted and delineated onto overlays using stereoscopes. We used each photograph with its matching stereo pairs for 3-dimensional viewing. We then delineated polygons on the overlays defining ground features, assigning classification to each polygon.

We used texture, height, pattern, life form, and position in the landscape in the decision process of delineating polygons and assigning map classes. When applicable, we assigned physiognomic modifiers in conjunction with the map class to describe physiognomic characteristics of the vegetation. Our standard approach is delineating larger polygons first, then continue delineating smaller polygons down to the USGS-NPS Vegetation Mapping Program's standard minimum mapping unit (MMU) of 0.5 hectares (1.25 acres). We mapped small upland islands with vegetation to 0.1 hectares (0.25 acres). The photointerpreted and classified polygon data are represented in the project's vegetation spatial database coverage (vegetation map) for use in geographic information systems.

Table F-1. Map class codes and names used in the Acadia NP Vegetation Mapping Project.

Map Class Code	Map Class Name
Forest - Conifer - Upland	
SF	Spruce - Fir Forest (conifer phase)
WPC	White Pine - Mixed Conifer Forest
WRP	Red Pine - White Pine Forest
Forest - Deciduous - Upland	
MDF	Beech - Birch - Maple Forest
Forest - Mixed - Upland	
OPF	Oak - Pine Forest
SFM	Spruce - Fir Forest (mixed phase)
WPM	White Pine - Hardwood Forest
Woodland - Conifer - Upland	
MCW	Mixed Conifer Woodland
WCW	White Cedar Woodland
JPW	Jack Pine Woodland
PPB	Pitch Pine - Heath Barren
PPC	Pitch Pine - Corema Woodland
PPW	Pitch Pine Woodland
Woodland - Deciduous - Upland	
ABF	Aspen - Birch Woodland/Forest Complex (forest phase)
ABW	Aspen - Birch Woodland/Forest Complex (woodland phase)
ABS	Aspen - Birch Woodland/Forest Complex (shrubland phase)
ROW	Red Oak Woodland
Woodland - Mixed - Upland	
MW	Mixed Conifer - Deciduous Woodland
Forest - Deciduous - Wetland	
MAS	Red Maple - Hardwood Swamp
Woodland - Conifer - Wetland	
CSW	Conifer Swamp Woodland (spruce-mixed phase)
WCS	Conifer Swamp Woodland (white cedar phase)
Dwarf Shrubland - Evergreen - Upland	
CB	Crowberry - Bayberry Headland
Dwarf Shrubland - Deciduous - Upland	
BBSS	Blueberry Bald - Summit Shrubland Complex
Graminoid - Upland	
AM	Dune Grassland
Sparse Vascular - Upland	
SVH	Open Headland - Beach Strand
SVT	Sparsely Vegetated Talus
Shrubland - Deciduous - Wetland	
ASP	Alder Shrubland
SG	Sweetgale Mixed Shrub Fen
Dwarf Shrubland - Evergreen - Wetland	
DSB	Dwarf Shrub Bog
FX	Fen Complex
Graminoid - Wetland	
TG	Tidal Marsh
SMG	Graminoid Shallow Marsh
Forb - Wetland	
OWM	Open Water - Deep Marsh Complex
Tidal Zone	
TZ	Tidal Algal Zone
TB	Tidal Beach
TM	Tidal Mud Flat
Small Island with Vegetation	
SIT	Small Island with Trees
SIS	Small Island with Shrubs
SIG	Small Island with Grass

Map Class Code	Map Class Name
SIR	Small Island with Rock
Cultural Vegetation	
EPL	Evergreen Plantation
SMD	Mixed Deciduous Shrubland
MGF	Mixed Grass - Forb
PGCH	Perennial Grass Crops
PGCS	Perennial Grass Crops with Sparse Shrubs
Non-vegetated Water	
WBP	Beaver Pond (non-vegetated)
WNP	Natural Pond (non-vegetated)
WST	Stream (non-vegetated)
WLK	Lake (non-vegetated)
WO	Ocean - Bay - Estuary (non-vegetated)
Land Use	
UR	Residential
UC	Commercial and Services
UT	Transportation and Roads
UM	Mixed Urban or Built-up Land
UBL	Other Urban or Built-up Land
ARB	Other Agricultural Land
BLQ	Strip Mines, Quarries, and Gravel Pits
No Data	
ND	No Data

Aerial Photographs

General Information about Color Infrared Film

Vegetation reflects more infrared than visible light, and this helps subtle differences in physical characteristics of species to show up as large differences on CIR film. CIR imagery presents a "false color" picture that combines infrared reflectance with green and red visible bands. The differences in reflectance create differences in color that allow the photointerpreter to see the distinguishing features of different plant species and vegetation communities. Reflectance is influenced by structure of the canopy, the orientation of the plants and their leaves, and the thickness and pigment content of leaves. For example, needle foliage of conifers creates internal shadows and the leaves themselves reflect less infrared radiation than hardwoods. This gives them a darker appearance in the CIR than hardwoods such as oak and aspen (Hershey and Befort 1995).

Texture is also important to the photointerpreter for identification. For trees, texture is influenced by type and orientation of leaves, crown size and shape, and branch structure. An uneven canopy height will appear more broken than an even canopy. Similarly, trees having small crowns will appear a finer texture than trees that have large crowns. Depending on the tree species, the texture can be rough or smooth, fine, lacy, billowy, compact, or any number of other descriptors. These are imprecise terms, but nonetheless important visual elements of the imagery. In contrast, herbaceous vegetation, including wetland and upland communities, generally tend to appear much smoother in texture than forests or woodlands (Hershey and Befort 1995).

Color infrared photography is not consistent enough to allow a species or type to be described precisely. Film batch, printing process, sun angle, light intensity, shadow, and exposure can all affect the appearance of CIR photography (Hershey and Befort 1995). Thus, ground verification of every set of photos is imperative to successful interpretation.

Aerial Photography of Acadia National Park

Participants at the project's scoping meeting agreed to acquire aerial photography during spring 1997 so that fieldwork and mapping could get underway during the following summer and fall seasons. CIR photographs were collected May 27 and 28, 1997 at a scale of 1:15,840. More details on the project's aerial photography is provided in the main body of the project report.

In hindsight, spring photography challenged the ability to map the vegetation classification system. Many deciduous types had little or no canopy at the time of photography, affecting our ability to discriminate within forest, woodland, and shrub alliances (e.g., birch-red maple and red oak woodlands) and in our ability to determine percent cover and tree height. Distinguishing vegetation types on the photographs is dependent on relative coverage, so where underdeveloped canopies existed, the interpreter needed to extrapolate to an expected full canopy. For example, oak trees in many places were lacking canopies so that the ground cover was easily viewed rather than the forest or woodland strata. We often attempted to extrapolate the percent canopy cover to later in the growing season, assuming we would be more successful identifying the vegetation type correctly. Unfortunately, we still had difficulty in mapping some stands, especially in determining the relative canopy cover of deciduous trees to evergreens in mixed stands, and in determining the relative canopy cover of individual species in deciduous stands.

Wetland vegetation types (e.g., tall-saturated grasslands, hydromorphic vegetation) were not discernable on the aerial photographs because it was too early in the growing season. Cattails, bulrushes, and other emergent species were barely starting their seasonal growth, thus the photographs revealed only the previous year's dead stalks. In addition, water lilies and submersed aquatic species such as pondweeds had not reached the surface of ponds and thus were not picked up on the photographs.

An example of an aerial photograph is presented below in Figure F-1. A prominent feature is the dark colored water of Eagle Lake. The road to Cadillac Mountain is seen winding up the hill on the east side of the lake (right side of photo). Acadia NP Headquarters can be seen northwest of Eagle Lake (top left corner). This photo exhibits several vegetation types that the map classes define, including upland deciduous and conifer forests, upland and wetland conifer woodlands, bald summits, and dwarf-shrub fen complexes. For purposes of general insight to how vegetation types are presented by the vegetation map, Figure F-2 shows an example of the map coverage in the same area. The vegetation displayed in this example is grouped into physiognomic and hydrologic categories (groups of vegetation types that share similar physiological and hydrological characteristics).
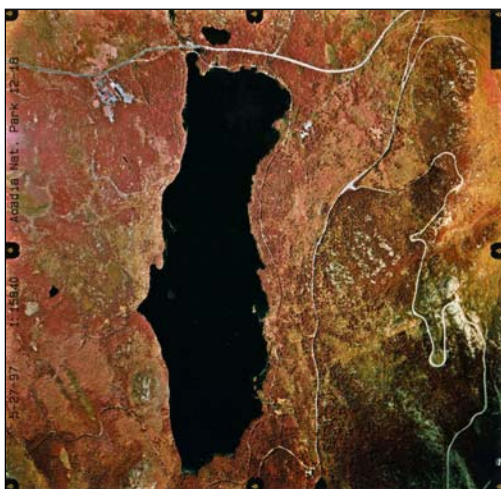

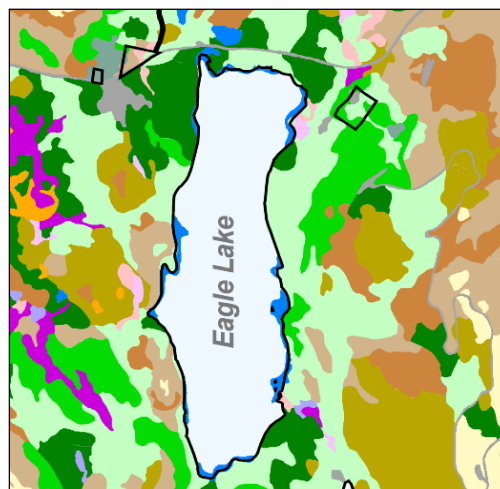**Figure F-1.** Example of an aerial photograph collected for the project (not to scale).

Figure F-2. Example of the project's vegetation map with groups of vegetation communities.

The Role of Fire

Fire is an important factor with Acadia NP's vegetation. The famed 1947 fire that burned most of the eastern side of Mount Desert Island is the most recent extensive fire (Figure F-3), but evidence of past burns is present in trees and soils throughout the park (Patterson et al.1983). Thus, the present vegetation includes areas of 50-year old forest and woodland as well as areas of older mature forest and woodland long-ago disturbance. At Acadia NP, early- to mid-successional processes are superimposed on edaphic and topographic factors, all of which must be considered in assessing the vegetation into community types and map classes.

Figure F-3. 1947 fire extent on Mount Desert Island.

Classification

The National Vegetation Classification System

The National Vegetation Classification System (NVCS) is a vegetation-based system that emphasizes natural and existing vegetation. The classification system has been primarily developed and implemented by The Nature Conservancy and their network of Natural Heritage programs over the past twenty years. The classification system is based on and well integrated with the major scientific efforts in the classification of vegetation. For example, the upper levels of the classification hierarchy are a modification of the systems proposed by UNESCO (1973) and Driscoll et al. (1984). The Nature Conservancy and the Natural Heritage Programs have further refined these systems by relating the repeating vegetation associations that occur on the landscape to these earlier systems. The system uses a combined physiognomic and floristic hierarchy. Table F-2 provides an example of the classification hierarchy.

Table F-2. The physiognomic-floristic hierarchy for terrestrial vegetation (from Grossman et al. 1998).

Level	Primary Basis For Classification	Example
Class	Growth form and structure of vegetation	Woodland
Subclass	Growth form characteristics, e.g., leaf phenology	Deciduous woodland
Group	Leaf types, corresponding to climate	Cold-deciduous woodland
Subgroup	Relative human impact (natural/semi-natural or cultural)	Natural/semi-natural
Formation	Additional physiognomic and environmental factors, including hydrology	Temporarily flooded cold-deciduous woodland
Alliance	Dominant/diagnostic species of uppermost or dominant stratum	Populus deltoids temporarily flooded woodland alliance
Association	Additional dominant/diagnostic species from any strata	*Populus deltoides - (Salix amygdaloides) / Salix exigua* woodland

Map Classification

We have devised 58 map classes to describe the vegetation and land features of Acadia NP and environs, as represented in the project's vegetation map. Of these, 33 map classes represent the 53 NVCS natural/semi-natural associations (vegetation communities) identified with this project, as defined by NatureServe. Another three map classes represent NVCS natural/semi-natural types at the alliance or formation level (not the association level), describing beach and tidal zone vegetation. There are five map classes describing cultural vegetation, representing NVCS vegetation at the formation level, three of which fall under the cultivated/planted subgroup. Another four map classes represent variations of small islands with vegetation (project-derived to map islands >0.1 hectares but less than the standard MMU of 0.5 hectares). Level II of the USGS land use and land cover classification (Anderson et al. 1976) is used to define seven land use map classes and three non-vegetated water map classes. Another two map classes are project-derived to map other non-vegetated bodies of water that did not fit into the USGS land use and land cover classification. One last map class describes areas of no map data; areas purposely not mapped, yet fall within the overlying extent of the project boundary. (Again, a listing of the 58 map classes is given in Table F-1.)

Map classes presented in this guide representing natural/semi-natural NVCS types are those defined by the mapping and ecology teams from the Upper Midwest Environmental Sciences Center, The Nature Conservancy, NatureServe, and Maine Natural Areas Program. In some cases, map classes represent one specified NVCS association level type (vegetation community). In other cases, map classes represents groups of vegetation communities. The USGS-NPS Vegetation Mapping Program promotes mapping at

the finest level of the NVCS (the association level) when possible. However, some important distinctions in the vegetation are not always visible on the aerial photograph for interpreting vegetation to the finest classification level. The environmental conditions or diagnostic species that distinguish closely related vegetation types are not always discernible on the imagery. Consequently, some map classes are aggregates of vegetation communities (associations). Table F-3 shows the 33 vegetation map classes with their link to the NVCS natural/semi-natural associations of Acadia NP.

To offer a point of clarification, a map polygon assigned with a map class that represents an aggregate of vegetation communities might characterize simply one of the vegetation communities or a mix of some or all of the communities. For example, let us assume Map Class A represents as a whole Vegetation Types 1, 2, and 3 (e.g., grouped together because of a mapping limitation). A particular map polygon classified as Map Class A might characterize Vegetation Types 1 and 3 at that location, where another polygon mapped elsewhere, again classified as Map Class A, might characterize Vegetation Type 2. When we describe on the following pages that a map class represents more than one vegetation community, we wish the reader to know that a particular map polygon may characterize one, some, or all vegetation types listed.

Table F-3. Map class crosswalk to NVCS natural/semi-natural vegetation communities (associations) of Acadia National Park.

Vegetation Map Classes (Map Class Code - Map Class Name)	NVCS Vegetation Community Name (NatureServe Association)	NVCS Synonym Community Name (NatureServe Association)	NatureServe CEGL Code	NVCS Code
Note: not all vegetation communities and map classes have a 1:1 relationship.				
Forest - Conifer - Upland				
SF - Spruce - Fir Forest (conifer phase)	*Picea rubens - Picea glauca* Forest	Maritime Spruce - Fir Forest	CEGL006151	I.A.8.N.c.15
WPC - White Pine - Mixed Conifer Forest	*Pinus strobus - Tsuga canadensis - Picea rubens* Forest AND/OR *Tsuga canadensis - (Betula alleghaniensis) - Picea rubens / Cornus canadensis* Forest	Eastern Hemlock - White Pine - Red Spruce Forest AND/OR Hemlock - Hardwood Forest	CEGL006324 AND/OR CEGL006129	I.A.8.N.b.13 AND/OR I.C.3.N.a.32
WRP - Red Pine - White Pine Forest	*Pinus strobus - Pinus resinosa / Cornus canadensis* Forest	Red Pine - White Pine Forest	CEGL006253	I.A.8.N.b.14
Forest - Deciduous - Upland				
MDF - Beech - Birch - Maple Forest	*Acer saccharum - Betula alleghaniensis - Fagus grandifolia / Viburnum lantanoides* Forest	Northern Hardwood Forest	CEGL006252	I.B.2.N.a.4
Forest - Mixed - Upland				
OPF - Oak - Pine Forest	*Quercus rubra - Acer rubrum - Betula* spp. *- Pinus strobus* Forest, *Pinus strobus - Quercus (rubra, velutina) - Fagus grandifolia* Forest, *Acer saccharum - Pinus strobus / Acer pensylvanicum* Forest, *Quercus rubra - (Quercus prinus) / Vaccinium* spp. / *Deschampsia flexuosa* Woodland, AND/OR *(Pinus strobus, Quercus rubra) / Danthonia spicata* Acid Bedrock Wooded Herbaceous Vegetation	Successional Oak - Pine Forest, White Pine - Oak Forest, Sugar Maple - White Pine Forest, Central Appalachian High-Elevation Red Oak Woodland, Northern Variant, AND/OR White Pine - Red Oak Bedrock Glade	CEGL006506, CEGL006293, CEGL005005, CEGL006134, AND/OR CEGL005101	I.B.2.N.a.39, I.C.3.N.a.21, I.C.3.N.a.300, II.B.2.N.a.24, AND/OR V.A.5.N.e.8
SFM - Spruce - Fir Forest (mixed phase)	*Picea rubens - Abies balsamea - Betula* spp. *- Acer rubrum* Forest AND/OR *Picea rubens - Betula alleghaniensis / Dryopteris campyloptera* Forest	Successional Spruce - Fir Forest AND/OR Red Spruce - Hardwoods Forest	CEGL006505 AND/OR CEGL006267	I.C.3.N.a.4
WPM - White Pine - Hardwood Forest	*Quercus rubra - Acer rubrum - Betula* spp. *- Pinus strobus* Forest, *Tsuga canadensis - (Betula alleghaniensis) - Picea rubens / Cornus canadensis* Forest, AND/OR *Acer saccharum - Pinus strobus / Acer pensylvanicum* Forest	Successional Oak - Pine Forest, Hemlock - Hardwood Forest, AND/OR Sugar Maple - White Pine Forest	CEGL006506, CEGL006129, AND/OR CEGL005005	I.B.2.N.a.39, I.C.3.N.a.32, AND/OR I.C.3.N.a.300

Vegetation Map Classes (Map Class Code - Map Class Name)	NVCS Vegetation Community Name (NatureServe Association)	NVCS Synonym Community Name (NatureServe Association)	NatureServe CEGL Code	NVCS Code
Woodland - Conifer - Upland				
MCW - Mixed Conifer Woodland	*Thuja occidentalis - Fraxinus pennsylvanica / Acer pensylvanicum* Woodland, *Picea rubens / Vaccinium angustifolium - Sibbaldiopsis tridentata* Woodland, *Picea rubens / Ribes glandulosum* Woodland, AND/OR *Picea mariana / Kalmia angustifolia* Woodland	Cedar Seepage Slope, Spruce - Fir Rocky Summit, Red Spruce Talus Slope Woodland, AND/OR Black Spruce / Heath Rocky Woodland	CEGL006508, CEGL006053, CEGL006250, AND/OR CEGL006292	II.A.4.N.b.1, II.A.4.N.b.3, AND/OR II.A.4.N.b.400
WCW - White Cedar Woodland	*Thuja occidentalis / Gaylussacia baccata - Vaccinium angustifolium* Woodland AND/OR *Thuja occidentalis - Fraxinus pennsylvanica / Acer pensylvanicum* Woodland	White-cedar Woodland AND/OR Cedar Seepage Slope	CEGL006411 AND/OR CEGL006508	II.A.4.N.b.1
JPW - Jack Pine Woodland	*Pinus banksiana / Kalmia angustifolia - Vaccinium* spp. Woodland	Jack Pine Heath Barren	CEGL006041	II.A.4.N.a.9
PPB - Pitch Pine - Heath Barren	*Pinus rigida / Vaccinium* spp. - *Gaylussacia baccata* Woodland	Pitch Pine / Blueberry spp. - Huckleberry Woodland	CEGL005046	II.A.4.N.a.26
PPC - Pitch Pine - Corema Woodland	*Pinus rigida / Corema conradii* Woodland	Coastal Pitch Pine Outcrop Woodland	CEGL006154	II.A.4.N.a.26
PPW - Pitch Pine Woodland	*Pinus rigida / Photinia melanocarpa / Deschampsia flexuosa - Schizachyrium scoparium* Woodland	Pitch Pine Rocky Summit	CEGL006116	II.A.4.N.a.26
Woodland - Deciduous - Upland				
ABF - Aspen - Birch Woodland/Forest Complex (forest phase)	*Populus (tremuloides, grandidentata) - Betula (populifolia, papyrifera)* Woodland	Early Successional Woodland/Forest	CEGL006303	II.B.2.N.a.10
ABW - Aspen - Birch Woodland/Forest Complex (woodland phase)	*Populus (tremuloides, grandidentata) - Betula (populifolia, papyrifera)* Woodland AND/OR *Betula alleghaniensis - Quercus rubra / Polypodium virginianum* Woodland	Early Successional Woodland/Forest AND/OR Red Oak Talus Slope Woodland	CEGL006303 AND/OR CEGL006320	II.B.2.N.a.10 AND/OR II.B.2.N.a.24
ABS - Aspen - Birch Woodland/Forest Complex (shrubland phase)	*Populus (tremuloides, grandidentata) - Betula (populifolia, papyrifera)* Woodland	Early Successional Woodland/Forest	CEGL006303	II.B.2.N.a.10
ROW - Red Oak Woodland	*Quercus rubra - Acer rubrum - Betula* spp. - *Pinus strobus* Forest AND/OR *Quercus rubra - (Quercus prinus) / Vaccinium* spp. / *Deschampsia flexuosa* Woodland	Successional Oak - Pine Forest AND/OR Central Appalachian High-Elevation Red Oak Woodland, Northern Variant	CEGL006506 AND/OR CEGL006134	I.B.2.N.a.39 AND/OR II.B.2.N.a.24

Vegetation Map Classes (Map Class Code - Map Class Name)	NVCS Vegetation Community Name (NatureServe Association)	NVCS Synonym Community Name (NatureServe Association)	NatureServe CEGL Code	NVCS Code
Woodland - Mixed - Upland				
MW - Mixed Conifer - Deciduous Woodland	*Picea rubens / Vaccinium angustifolium - Sibbaldiopsis tridentata* Woodland, *Populus (tremuloides, grandidentata) - Betula (populifolia, papyrifera)* Woodland, AND/OR *(Pinus strobus, Quercus rubra) / Danthonia spicata* Acid Bedrock Wooded Herbaceous Vegetation	Spruce - Fir Rocky Summit, Early Successional Woodland/Forest, AND/OR White Pine - Red Oak Bedrock Glade	CEGL006053, CEGL006303, AND/OR CEGL005101	II.A.4.N.b.3, II.B.2.N.a.10, AND/OR V.A.5.N.e.8
Forest - Deciduous - Wetland				
MAS - Red Maple - Hardwood Swamp	*Acer rubrum - Fraxinus* spp. */ Nemopanthus mucronatus - Vaccinium corymbosum* Forest AND/OR *Acer rubrum / Alnus incana - Ilex verticillata / Osmunda regalis* Woodland	Northern Hardwood Seepage Swamp AND/OR Red Maple Swamp Woodland	CEGL006220 AND/OR CEGL006395	I.B.2.N.e.1 AND/OR II.B.2.N.e.1
Woodland - Conifer - Wetland				
CSW - Conifer Swamp Woodland (spruce-mixed phase)	*Picea rubens - Acer rubrum / Nemopanthus mucronatus* Forest AND/OR *Picea mariana / (Vaccinium corymbosum, Gaylussacia baccata) / Sphagnum* sp. Woodland	Red Maple - Conifer Acidic Swamp AND/OR Black Spruce Woodland Bog	CEGL006198 AND/OR CEGL006098	I.C.3.N.d.10 AND/OR II.A.4.N.f.13
WCS - Conifer Swamp Woodland (white cedar phase)	*Thuja occidentalis - Abies balsamea / Ledum groenlandicum / Carex trisperma* Woodland AND/OR *Picea mariana / (Vaccinium corymbosum, Gaylussacia baccata) / Sphagnum* sp. Woodland	Northern White-cedar Wooded Fen AND/OR Black Spruce Woodland Bog	CEGL006507 AND/OR CEGL006098	II.A.4.N.f.11 AND/OR II.A.4.N.f.13
Dwarf Shrubland - Evergreen - Upland				
CB - Crowberry - Bayberry Headland	*Morella pensylvanica - Empetrum nigrum* Dwarf-shrubland	Crowberry - Bayberry Maritime Shrubland	CEGL006510	IV.A.1.N.b.7
Dwarf Shrubland - Deciduous - Upland				
BBSS - Blueberry Bald - Summit Shrubland Complex	*Vaccinium angustifolium - Sorbus americana / Sibbaldiopsis tridentata* Dwarf-shrubland	Blueberry Granite Barrens	CEGL005094	IV.B.2.N.a.1
Graminoid - Upland				
AM - Dune Grassland	*Ammophila breviligulata - Lathyrus japonicus* Herbaceous Vegetation	Northern Beachgrass Dune	CEGL006274	V.A.5.N.c.2

Vegetation Map Classes (Map Class Code - Map Class Name)	NVCS Vegetation Community Name (NatureServe Association)	NVCS Synonym Community Name (NatureServe Association)	NatureServe CEGL Code	NVCS Code
Sparse Vascular - Upland				
SVH - Open Headland - Beach Strand	*Solidago sempervirens - (Rhodiola rosea) - Juniperus horizontalis* Sparse Vegetation AND/OR *Cakile edentula* ssp. *edentula - Mertensia maritima* Sparse Vegetation	Northern Maritime Rocky Headlands AND/OR Sea-rocket - Oysterleaf Sparse Vegetation	CEGL006529 AND/OR CEGL006106	VII.A.2.N.a.4 AND/OR VII.C.2.N.a.2
SVT - Sparsely Vegetated Talus	*Polypodium (virginianum, appalachianum) / Lichen* spp. Nonvascular Vegetation	Northern Lichen Talus Barrens	CEGL006534	VI.B.1.N.c.300
Shrubland - Deciduous - Wetland				
ASP - Alder Shrubland	*Alnus incana - Cornus sericea / Clematis virginiana* Shrubland AND/OR *Alnus incana* ssp. *rugosa - Nemopanthus mucronatus / Sphagnum* spp. Shrubland	Alluvial Alder Thicket AND/OR Northern Peatland Shrub Swamp	CEGL006062 AND/OR CEGL006158	III.B.2.N.d.9 AND/OR III.B.2.N.e.9
SG - Sweetgale Mixed Shrub Fen	*Myrica gale - Spiraea alba - Chamaedaphne calyculata* Shrubland	Sweetgale Mixed Shrub Swamp	CEGL006512	III.B.2.N.g.9
Dwarf Shrubland - Evergreen - Wetland				
DSB - Dwarf Shrub Bog	*Kalmia angustifolia - Chamaedaphne calyculata - (Picea mariana) / Cladina* spp. Dwarf-shrubland AND/OR *Trichophorum caespitosum - Gaylussacia dumosa / Sphagnum (fuscum, rubellum, magellanicum)* Herbaceous Vegetation	Northern Dwarf-shrub Bog AND/OR Maritime Peatland Sedge Lawn	CEGL006225 AND/OR CEGL006260	IV.A.1.N.g.1 AND/OR V.A.5.N.h.1
FX - Fen Complex	*Alnus incana* ssp. *rugosa - Nemopanthus mucronatus / Sphagnum* spp. Shrubland, *Myrica gale - Spiraea alba - Chamaedaphne calyculata* Shrubland, *Kalmia angustifolia - Chamaedaphne calyculata - (Picea mariana) / Cladina* spp. Dwarf-shrubland, *Empetrum nigrum - Gaylussacia dumosa - Rubus chamaemorus / Sphagnum* spp. Dwarf-shrubland, *Chamaedaphne calyculata / Eriophorum virginicum / Sphagnum rubellum* Dwarf-shrubland, *Carex stricta - Carex vesicaria* Seasonally Flooded Herbaceous Vegetation, *Calamagrostis canadensis - Scirpus* spp. *- Dulichium arundinaceum* Herbaceous Vegetation, *Carex (lasiocarpa, utriculata, canescens)* Herbaceous Vegetation, AND/OR *Carex (oligosperma, exilis) - Chamaedaphne calyculata* Shrub Herbaceous Vegetation	Northern Peatland Shrub Swamp, Sweetgale Mixed Shrub Swamp, Northern Dwarf-shrub Bog, Maritime Crowberry Bog, Leatherleaf Acidic Fen, Eastern Tussock Sedge Meadow, Seasonally Flooded Mixed Graminoid Meadow, Slender Sedge Fen, AND/OR Few-seeded Sedge - Leatherleaf Fen	CEGL006158, CEGL006512, CEGL006225, CEGL006248, CEGL006513, CEGL006412, CEGL006519, CEGL006521, AND/OR CEGL006524	III.B.2.N.e.9, III.B.2.N.g.9, IV.A.1.N.g.1, IV.A.1.N.g.4, V.A.5.N.k.36, V.A.5.N.k.39, V.A.5.N.m.7, AND/OR V.A.7.N.o.3

Vegetation Map Classes (Map Class Code - Map Class Name)	NVCS Vegetation Community Name (NatureServe Association)	NVCS Synonym Community Name (NatureServe Association)	NatureServe CEGL Code	NVCS Code
Graminoid - Wetland				
TG - Tidal Marsh	*Typha angustifolia - Hibiscus moscheutos* Herbaceous Vegetation AND/OR *Spartina patens - Distichlis spicata - (Juncus gerardii)* Herbaceous Vegetation	Brackish Tidal Marsh, Cattail Variant AND/OR Spartina High Salt Marsh	CEGL004201 AND/OR CEGL006006	V.A.5.N.n.2 AND/OR V.A.5.N.n.11
SMG - Graminoid Shallow Marsh	*Carex stricta - Carex vesicaria* Seasonally Flooded Herbaceous Vegetation, *Calamagrostis canadensis - Scirpus* spp. - *Dulichium arundinaceum* Herbaceous Vegetation, *Juncus militaris* Herbaceous Vegetation, *Typha (angustifolia, latifolia) - (Schoenoplectus* spp.) Eastern Herbaceous Vegetation, AND/OR *Carex (lasiocarpa, utriculata, canescens)* Herbaceous Vegetation	Eastern Tussock Sedge Meadow, Seasonally Flooded Mixed Graminoid Meadow, Bayonet Rush Herbaceous Vegetation, Eastern Cattail Marsh, AND/OR Slender Sedge Fen	CEGL006412, CEGL006519, CEGL006345, CEGL006153, AND/OR CEGL006521	V.A.5.N.k.36, V.A.5.N.k.39, V.A.5.N.l.3, V.A.5.N.l.9, AND/OR V.A.5.N.m.7
Forb - Wetland				
OWM - Open Water - Deep Marsh Complex	*Eriocaulon aquaticum - Lobelia dortmanna* Herbaceous Vegetation, *Typha (angustifolia, latifolia) - (Schoenoplectus* spp.) Eastern Herbaceous Vegetation, *Schoenoplectus (tabernaemontani, acutus)* Eastern Herbaceous Vegetation, *Vallisneria americana - Potamogeton perfoliatus* Herbaceous Vegetation, AND/OR *Nuphar lutea* ssp. *advena - Nymphaea odorata* Herbaceous Vegetation	Seven-angle Pipewort - Dortmann's Cardinal-flower Herbaceous Vegetation, Eastern Cattail Marsh, Bulrush Deepwater Marsh, Open Water Marsh with Mixed Submergents/Emergents, AND/OR Water Lily Aquatic Wetland	CEGL006346, CEGL006153, CEGL006275, CEGL006196, AND/OR CEGL002386	V.A.5.N.l.2, V.A.5.N.l.9, V.A.5.N.l.16, V.C.2.N.a.17, AND/OR V.C.2.N.a.102

Map Attribute Codes and Conventions

In addition to applying map classes to polygon mapping, we interpreted the physiognomic features of the vegetation of that polygon. We added physiognomic modifier classes to the map classes for all polygons defining vegetation (whether natural or cultural). These physiognomic classes describe the growth structure of the vegetation within a polygon (Table F-4).

To ascribe map class and physiognomic modifier information to interpreted polygons, we assigned map attribute codes. A map attribute code is made up of a map class code and a physiognomic modifier code. The following briefly explains the conventional practice for applying map attribute codes to polygons. The format first applies the map class, and then (separated by a hyphen) a combination of alternating alpha and numeric codes for the physiognomic modifiers. The result is a string of codes to describe in detail the features of a mapped polygon.

The attribute code begins with the ***map class code***, which represents either a vegetation type(s) or a land use or land cover feature. The map class code is made up of 2 to 4 ***alpha*** characters. *Examples:*
SF, PPW, MW, BBSS, MAS

A series of physiognomic modifier codes follow the map class code when applicable. A ***hyphen*** is placed between the map class code and the string of physiognomic modifier codes. All vegetation map class codes receive physiognomic modifier codes.

The first physiognomic modifier code represents ***Coverage Density***. It describes the coverage (a percent range) of the vegetation that the map class is representing within the polygon. Typically, the modifier defines the coverage of the higher plant life form (e.g., density of tree canopy, not density of tree canopy and shrub layer). The modifier is a single ***numeric*** code. All vegetation map class codes receive this modifier. *Examples:*
SF-**1,** PPW-**2**, MW-**2**, BBSS-**2**, MAS-**1**

The second physiognomic code represents ***Coverage Pattern***. It describes the pattern or distribution of the vegetation that the map class is representing within the polygon. Like the density modifier, the pattern modifier typically defines the growth pattern of the higher plant life form. This modifier is a single ***alpha*** code and follows the Coverage Density numeric code. All vegetation map class codes receive this modifier. *Examples:*
SF-1**A** PPW-2**B**, MW-2**B**, BBSS-2**C**, MAS-1**A**

The third physiognomic code represents ***Height***. It describes the average height of woody terrestrial vegetation that the map class is representing within the polygon. There is no representation within the map code of whether the height is indicative of average or super-canopy. The modifier is a single ***numeric*** code and follows the Coverage Pattern alpha code. Only map classes representing vegetation types under the NVCS forest, woodland, shrubland, and dwarf-shrubland Formation classes receive this modifier. *Examples:*
SF-1A**3** PPW-2B**4**, MW-2B**4**, MAS-1A**3**

More information about the Acadia NP Vegetation Mapping Project and the USGS-NPS Vegetation Mapping Program can be found on the Internet at http://biology.usgs.gov/npsveg.

Table F-4. Key to physiognomic modifier codes.

Coverage Density (all vegetation map classes)
1 - Closed Canopy/Continuous (60-100% coverage)
2 - Open Canopy/Discontinuous (25-60% coverage)
3 - Dispersed-Sparse Canopy (10-25% coverage)
Coverage Pattern (all vegetation map classes)
A - Evenly Dispersed
B - Clumped/Bunched
C - Gradational/Transitional
D - Regularly Alternating
Height (forest, woodland, shrubland, & dwarf-shrubland map classes)
1 - 30-50 meters (98-162 feet)*
2 - 20-30 meters (65-98 feet)
3 - 12-20 meters (40-65 feet)
4 - 5-12 meters (16-40 feet)
5 - 0.5-5 meters (1.5-16 feet)
6 - <0.5 meters (<1.5 feet)
* Height code "1" was not used for ACAD vegetation mapping

Map Classification Descriptions

The following pages are descriptions to map classes that we used for the Acadia NP Vegetation Mapping Project.

Appendix G

Accuracy Assessment Contingency Matrix

Using the Accuracy Assessment Contingency Matrix

In the electronic version, the accuracy assessment matrix is a separate spreadsheet. The accuracy assessment contingency matrix is an array of numbers set out in rows and columns which reveal the number of polygons assigned to a particular vegetation type(s) relative to the actual vegetation type as verified on the ground. The columns represent National Vegetation Classification System (NVCS) associations (vegetation community) as per NatureServe (2003) listed by their Community Global Element (CEGL), and the rows represent the map classes (listed by their map class codes). The accuracies of each map class are described as both producers' accuracy with errors of inclusion (commission errors), and users' accuracy with errors of exclusion (omission errors) present in the mapping.

A key to the names of map class codes and vegetation association CEGL codes are listed below the matrix table.

Appendix H

Plant Species List of Acadia National Park

More than 400 plant species were identified and documented in 179 vegetation samples collected for the Acadia National Park Vegetation Mapping Project. Plant species, along with other sample data, were entered into the PLOTS Database System (The Nature Conservancy 1997) to produce the Project's vegetation database. The following list of plant species was generated from the vegetation database. The list is not intended to be comprehensive of every species in the Park. Plant species are organized alphabetically within plant families. Nomenclature follows the PLANTS database (U.S. Department of Agriculture 1996).

Table H-1. Plant species list of Acadia National Park summarized by family.

Family	Scientific Name	Common Name
Aceraceae	*Acer pensylvanicum* L.	striped maple
	Acer rubrum L.	red maple
	Acer saccharum Marsh.	sugar maple
	Acer spicatum Lam.	mountain maple
Adelanthaceae	*Odontoschisma* (Dum.) Dum.	odontoschisma
Alismataceae	*Sagittaria latifolia* Willd.	broadleaf arrowhead
Amblystegiaceae	Drepanocladus *(C. Müll.) G. Roth*	drepanocladus moss
Anacardiaceae	Rhus hirta *(L.) Sudworth*	staghorn sumac
	Toxicodendron radicans ssp. radicans (L.) Kuntze	eastern poison ivy
Apiaceae	*Angelica atropurpurea* L.	purplestem angelica
	Ligusticum scoticum L.	Scottish licoriceroot
Apocynaceae	*Apocynum androsaemifolium* L.	spreading dogbane
Aquifoliaceae	*Ilex glabra* (L.) Gray	inkberry
	Ilex verticillata (L.) Gray	common winterberry
	Nemopanthus mucronatus (L.) Loes.	catberry
Araceae	*Arisaema triphyllum* (L.) Schott	Jack in the pulpit
	Symplocarpus foetidus (L.) Salisb. ex Nutt.	skunk cabbage
Araliaceae	*Aralia nudicaulis* L.	wild sarsaparilla
Asteraceae	*Achillea millefolium* L.	common yarrow
	Aster cordifolius L.	common blue wood aster
	Aster L.	aster
	Aster lateriflorus (L.) Britt.	calico aster
	Aster macrophyllus L.	bigleaf aster
	Aster puniceus L.	purplestem aster
	Aster X blakei (Porter) House (pro sp.)	Blake's aster
	Bidens connata Muhl. ex Willd.	purplestem beggarticks
	Bidens L.	beggartick
	Doellingeria umbellata (P. Mill.) Nees	
	Euthamia graminifolia (L.) Nutt.	flattop goldentop
	Hieracium canadense Michx.	Canadian hawkweed

Family	Scientific Name	Common Name
	Hieracium L.	hawkweed
	Hieracium paniculatum L.	Allegheny hawkweed
	Hieracium pilosella L.	mouseear hawkweed
	Oclemena acuminata (Michx.) Greene	
	Oclemena nemoralis (Ait.) Greene	
	Prenanthes alba L.	white rattlesnakeroot
	Prenanthes trifoliolata (Cass.) Fern.	gall of the earth
	Solidago bicolor L.	white goldenrod
	Solidago L.	goldenrod
	Solidago puberula Nutt.	downy goldenrod
	Solidago rugosa P. Mill.	wrinkleleaf goldenrod
	Solidago sempervirens L.	seaside goldenrod
	Solidago simplex ssp. randii (Porter) Ringius	Rand's goldenrod
	Solidago uliginosa Nutt.	bog goldenrod
	Solidago uliginosa var. linoides (Torr. & Gray) Fern.	bog goldenrod
Aulacomniaceae	*Aulacomnium palustre* (Hedw.) Schwaegr.	aulacomnium moss
	Aulacomnium Schwaegr.	aulacomnium moss
Balsaminaceae	*Impatiens capensis* Meerb.	jewelweed
	Bartramia pomiformis Hedw.	bartramia moss
Berberidaceae	*Berberis thunbergii* DC.	Japanese barberry
Betulaceae	*Alnus incana* (L.) Moench	mountain alder
	Alnus serrulata (Ait.) Willd.	hazel alder
	Alnus viridis ssp. crispa (Ait.) Turrill	American green alder
	Betula alleghaniensis Britt.	yellow birch
	Betula L.	birch
	Betula papyrifera Marsh.	paper birch
	Betula papyrifera var. cordifolia (Regel) Fern.	mountain paper birch
	Betula populifolia Marsh.	gray birch
	Betula X caerulea Blanch. (pro sp.)	birch
	Betula X sargentii *Dugle*	Sargent's birch
	Corylus cornuta Marsh.	beaked hazelnut
	Ostrya virginiana (P. Mill.) K. Koch	eastern hophornbeam
Blechnaceae	*Woodwardia virginica* (L.) Sm.	Virginia chainfern
Brachytheciaceae	*Brachythecium* Schimp. in B.S.G.	brachythecium moss
Bryaceae	*Bryum argenteum* Hedw.	silvergreen bryum moss
	Bryum Hedw.	bryum moss
	Pohlia Hedw.	pohlia moss
Campanulaceae	*Campanula rotundifolia* L.	bluebell bellflower
Caprifoliaceae	*Diervilla lonicera* P. Mill.	northern bush honeysuckle
	Linnaea borealis L.	twinflower
	Lonicera canadensis Bartr. ex Marsh.	American fly honeysuckle
	Lonicera villosa (Michx.) J.A. Schultes	mountain fly honeysuckle
	Viburnum acerifolium L.	mapleleaf viburnum
	Viburnum lantanoides Michx.	hobblebush
	Viburnum lentago L.	nannyberry
	Viburnum nudum var. cassinoides (L.) Torr. & Gray	possumhaw
Caryophyllaceae	*Cerastium arvense* L.	field chickweed

Family	Scientific Name	Common Name
	Minuartia glabra (Michx.) Mattf.	Appalachian stitchwort
	Minuartia groenlandica (Retz.) Ostenf.	Greenland stitchwort
	Sagina nodosa ssp. nodosa (L.) Fenzl	knotted pearlwort
Cephaloziellaceae	*Cephaloziella* (Spruce) Steph.	cephaloziella
Chenopodiaceae	*Atriplex patula* L.	spear saltbush
Cistaceae	*Lechea intermedia* Leggett ex Britt.	largepod pinweed
Cladoniaceae	*Cladina* (Nyl.) Nyl.	reindeer lichen
	Cladina arbuscula (Wallr.) Hale & Culb.	reindeer lichen
	Cladina rangiferina (L.) Nyl.	greygreen reindeer lichen
	Cladina stellaris (Opiz) Brodo	star reindeer lichen
	Cladonia cristatella Tuck.	cup lichen
	Cladonia P. Browne	cup lichen
	Cladonia pyxidata (L.) Hoffm.	cup lichen
Clusiaceae	*Hypericum boreale* (Britt.) Bickn.	northern St. Johnswort
	Hypericum gentianoides (L.) B.S.P.	orangegrass
	Triadenum fraseri (Spach) Gleason	Fraser's marsh St. Johnswort
Conocephalaceae	*Conocephalum* Wigg.	conocephalum
Convolvulaceae	*Calystegia sepium* (L.) R. Br.	hedge false bindweed
Cornaceae	*Cornus canadensis* L.	bunchberry dogwood
Crassulaceae	*Sedum rosea* (L.) Scop.	roseroot stonecrop
Cupressaceae	*Juniperus communis* L.	common juniper
	Juniperus horizontalis Moench	creeping juniper
	Thuja occidentalis L.	eastern arborvitae
Cyperaceae	*Carex arctata* Boott ex Hook.	drooping woodland sedge
	Carex atlantica ssp. atlantica Bailey	Atlantic sedge
	Carex atlantica ssp. capillacea (Bailey) Reznicek	prickly bog sedge
	Carex brunnescens (Pers.) Poir.	brownish sedge
	Carex canescens L.	silvery sedge
	Carex communis Bailey	fibrousroot sedge
	Carex debilis Michx.	white edge sedge
	Carex echinata Murr.	prickley sedge
	Carex exilis Dewey	coastal sedge
	Carex folliculata L.	northern long sedge
	Carex gracillima Schwein.	graceful sedge
	Carex gynandra Schwein.	nodding sedge
	Carex gynocrates Wormsk. ex Drej.	northern bog sedge
	Carex hormathodes Fern.	marsh straw sedge
	Carex intumescens Rudge	greater bladder sedge
	Carex L.	sedge
	Carex lacustris Willd.	hairy sedge
	Carex lasiocarpa Ehrh.	woollyfruit sedge
	Carex laxiflora Lam.	broad looseflower sedge
	Carex leptalea Wahlenb.	bristlystalked sedge
	Carex leptonervia (Fern.) Fern.	nerveless woodland sedge
	Carex lucorum Willd. ex Link	Blue Ridge sedge
	Carex lurida Wahlenb.	shallow sedge
	Carex magellanica ssp. irrigua (Wahlenb.) Hulten	boreal bog sedge

Family	Scientific Name	Common Name
	Carex magellanica ssp. magellanica Lam.	little sedge
	Carex nigra (L.) Reichard	smooth black sedge
	Carex novae-angliae Schwein.	New England sedge
	Carex oligosperma Michx.	fewseed sedge
	Carex ovalis Goodenough	sedge
	Carex paleacea Schreb. ex Wahlenb.	chaffy sedge
	Carex pallescens L.	pale sedge
	Carex pedunculata Muhl. ex Willd.	longstalk sedge
	Carex projecta Mackenzie	necklace sedge
	Carex rosea Schkuhr ex Willd.	rosy sedge
	Carex rugosperma Mackenzie	parachute sedge
	Carex scabrata Schwein	eastern rough sedge
	Carex scoparia Schkuhr ex Willd.	broom sedge
	Carex stricta Lam.	uptight sedge
	Carex tonsa (Fern.) Bickn.	shaved sedge
	Carex tribuloides Wahlenb.	blunt broom sedge
	Carex trisperma Dewey	threeseeded sedge
	Carex utriculata Boott	Northwest Territory sedge
	Carex wiegandii Mackenzie	Wiegand's sedge
	Dulichium arundinaceum (L.) Britt.	threeway sedge
	Eleocharis acicularis (L.) Roemer & J.A. Schultes	needle spikerush
	Eleocharis obtusa (Willd.) J.A. Schultes	blunt spikesedge
	Eriophorum angustifolium Honckeny	tall cottongrass
	Eriophorum tenellum Nutt.	fewnerved cottongrass
	Eriophorum vaginatum var. spissum (Fern.) Boivin	tussock cottongrass
	Eriophorum virginicum L.	tawny cottongrass
	Rhynchospora alba (L.) Vahl	whitebeaked rush
	Scirpus atrocinctus Fern.	blackgirdle bulrush
	Scirpus cyperinus (L.) Kunth	woolgrass
	Trichophorum cespitosum (L.) Hartman	
Dennstaedtiaceae	*Dennstaedtia punctilobula* (Michx.) T. Moore	eastern hayscented fern
	Pteridium aquilinum (L.) Kuhn	western brackenfern
Dicranaceae	*Dicranella* (C. M□ll.) Schimp.	dicranella moss
	Dicranum flagellare Hedw.	dicranum moss
	Dicranum fulvum Hook.	dicranum moss
	Dicranum fuscescens Turn.	dicranum moss
	Dicranum Hedw.	dicranum moss
	Dicranum polysetum Sw.	dicranum moss
	Dicranum scoparium Hedw.	dicranum moss
	Dicranum undulatum Brid.	undulate dicranum moss
	Paraleucobryum (Lindb.) Loeske	paraleucobryum moss
	Paraleucobryum longifolium (Hedw.) Loeske	longleaf paraleucobryum moss
Droseraceae	*Drosera intermedia* Hayne	spoonleaf sundew
	Drosera rotundifolia L.	roundleaf sundew
Dryopteridaceae	*Athyrium filix-femina* (L.) Roth	common ladyfern
	Dryopteris carthusiana (Vill.) H.P. Fuchs	spinulose woodfern
	Dryopteris cristata (L.) Gray	crested woodfern

Family	Scientific Name	Common Name
	Dryopteris intermedia (Muhl. ex Willd.) Gray	intermediate woodfern
	Dryopteris marginalis (L.) Gray	marginal woodfern
	Gymnocarpium dryopteris (L.) Newman	western oakfern
	Onoclea sensibilis L.	sensitive fern
	Polystichum acrostichoides (Michx.) Schott	Christmas fern
Empetraceae	*Corema conradii* (Torr.) Torr. ex Loud.	broom crowberry
	Empetrum nigrum L.	black crowberry
Equisetaceae	*Equisetum sylvaticum* L.	woodland horsetail
Ericaceae	*Andromeda polifolia* L.	bog rosemary
	Chamaedaphne calyculata (L.) Moench	leatherleaf
	Epigaea repens L.	trailing arbutus
	Gaultheria hispidula (L.) Muhl. ex Bigelow	creeping snowberry
	Gaultheria procumbens L.	eastern teaberry
	Gaylussacia baccata (Wangenh.) K. Koch	black huckleberry
	Gaylussacia dumosa (Andr.) Torr. & Gray	dwarf huckleberry
	Kalmia angustifolia L.	sheep laurel
	Kalmia polifolia Wangenh.	bog laurel
	Ledum groenlandicum Oeder	bog Labradortea
	Rhododendron canadense (L.) Torr.	rhodora
	Vaccinium angustifolium Ait.	lowbush blueberry
	Vaccinium boreale Hall & Aalders	northern blueberry
	Vaccinium corymbosum L.	highbush blueberry
	Vaccinium macrocarpon Ait.	cranberry
	Vaccinium myrtilloides Michx.	velvetleaf huckleberry
	Vaccinium oxycoccos L.	small cranberry
	Vaccinium vitis-idaea L.	lingonberry
Fabaceae	*Lathyrus japonicus* Willd.	sea peavine
	Trifolium L.	clover
Fagaceae	*Fagus grandifolia* Ehrh.	American beech
	Quercus ilicifolia Wangenh.	bear oak
	Quercus L.	oak
	Quercus rubra L.	northern red oak
Fissidentaceae	*Fissidens* Hedw.	fissidens moss
Fontinalaceae	*Fontinalis* Hedw.	fontinalis moss
Gentianaceae	*Bartonia paniculata* (Michx.) Muhl.	twining screwstem
Grimmiaceae	*Grimmia* Hedw.	grimmia dry rock moss
Grossulariaceae	*Ribes triste* Pallas	red currant
Haloragaceae	*Proserpinaca pectinata* Lam.	combleaf mermaidweed
Hamamelidaceae	*Hamamelis virginiana* L.	American witchhazel
Hylocomiaceae	*Hylocomium* Schimp. in B.S.G.	hylocomium feather moss
	Hylocomium splendens (Hedw.) Schimp. in B.S.G.	splendid feather moss
	Pleurozium schreberi (Brid.) Mitt.	Schreber's big red stem moss
	Rhytidiadelphus triquetrus (Hedw.) Warnst.	rough goose neck moss
Hypnaceae	*Callicladium haldanianum* (Grev.) Crum	callicladium moss
	Hypnum Hedw.	hypnum moss
	Hypnum imponens Hedw.	hypnum moss
	Ptilium crista-castrensis (Hedw.) De Not.	knights plume moss

Family	Scientific Name	Common Name
Iridaceae	*Iris setosa var. canadensis* M. Foster ex B.L. Robins. & Fern.	Canada beachhead iris
	Iris versicolor L.	harlequin blueflag
	Sisyrinchium montanum Greene	mountain blueeyed grass
Jubulaceae	Frullania *Raddi*	frullania
Juncaceae	*Juncus balticus* Willd.	Baltic rush
	Juncus brevicaudatus (Engelm.) Fern.	narrowpanicle rush
	Juncus bufonius L.	toad rush
	Juncus canadensis J. Gay ex Laharpe	Canadian rush
	Juncus effusus L.	common rush
	Juncus filiformis L.	thread rush
	Juncus gerardii Loisel.	saltmeadow rush
	Juncus militaris Bigelow	bayonet rush
	Juncus pelocarpus E. Mey.	brownfruit rush
	Luzula DC.	woodrush
	Luzula luzuloides (Lam.) Dandy & Wilmott	oakforest woodrush
Juncaginaceae	*Triglochin maritimum* L.	seaside arrowgrass
Lamiaceae	*Lycopus americanus* Muhl. ex W. Bart.	American waterhorehound
	Lycopus L.	waterhorehound
	Lycopus uniflorus Michx.	northern bugleweed
	Lycopus virginicus L.	Virginia waterhorehound
	Prunella vulgaris L.	common selfheal
	Scutellaria galericulata L.	marsh skullcap
Lentibulariaceae	*Utricularia cornuta* Michx.	horned bladderwort
	Utricularia purpurea Walt.	eastern purple bladderwort
Lepidoziaceae	*Bazzania trilobata* (L.) S. Gray	threelobed bazzania
Leucobryaceae	*Leucobryum glaucum* (Hedw.) □ngstr. in Fries	leucobryum moss
	Leucobryum Hampe	leucobryum moss
Liliaceae	*Clintonia borealis* (Ait.) Raf.	yellow bluebeadlily
	Maianthemum canadense Desf.	Canada beadruby
	Maianthemum trifolium (L.) Sloboda	threeleaf false Solomon's seal
	Medeola virginiana L.	Indian cucumberroot
	Trillium erectum L.	red trillium
	Trillium undulatum Willd.	painted trillium
	Uvularia sessilifolia L.	sessileleaf bellwort
Lycopodiaceae	*Huperzia appalachiana* Beitel & Mickel	
	Lycopodium annotinum L.	stiff clubmoss
	Lycopodium dendroideum Michx.	tree groundpine
	Lycopodium L.	clubmoss
	Lycopodium obscurum L.	rare clubmoss
Mniaceae	*Mnium* Hedw.	mnium calcareous moss
Monotropaceae	*Monotropa uniflora* L.	Indianpipe
Myricaceae	*Comptonia peregrina* (L.) Coult.	sweet fern
	Morella pensylvanica (Mirbel) Kartesz, comb. nov. ined.	
	Myrica gale L.	sweetgale
Oleaceae	*Fraxinus americana* L.	white ash
	Fraxinus pennsylvanica Marsh.	green ash
Onagraceae	*Epilobium leptophyllum* Raf.	bog willowherb

Family	Scientific Name	Common Name
Orchidaceae	*Arethusa bulbosa* L.	dragon's mouth
	Calopogon tuberosus (L.) B.S.P.	tuberous grasspink
	Cypripedium acaule Ait.	pink lady's slipper
	Goodyera pubescens (Willd.) R. Br. ex Ait. f.	downy rattlesnake plantain
	Goodyera repens (L.) R. Br. ex Ait. f.	lesser rattlesnake plantain
	Malaxis unifolia Michx.	green addersmouth orchid
	Platanthera L.C. Rich.	bog orchid
	Pogonia ophioglossoides (L.) Ker-Gawl.	snakemouth orchid
Orobanchaceae	*Epifagus virginiana* (L.) W. Bart.	beechdrops
Osmundaceae	*Osmunda cinnamomea* L.	cinnamon fern
	Osmunda claytoniana L.	interrupted fern
	Osmunda regalis L.	royal fern
Oxalidaceae	*Oxalis montana* Raf.	mountain woodsorrel
	Oxalis stricta L.	common yellow oxalis
Parmeliaceae	*Cetraria islandica* (L.) Ach.	island cetraria lichen
	Parmelia Ach.	shield lichen
Pelliaceae	*Pellia* Raddi	pellia
Pinaceae	*Abies balsamea* (L.) P. Mill.	balsam fir
	Larix laricina (Du Roi) K. Koch	tamarack
	Picea glauca (Moench) Voss	white spruce
	Picea mariana (P. Mill.) B.S.P.	black spruce
	Picea rubens Sarg.	red spruce
	Pinus banksiana Lamb.	jack pine
	Pinus resinosa Soland.	red pine
	Pinus rigida P. Mill.	pitch pine
	Pinus strobus L.	eastern white pine
	Tsuga canadensis (L.) Carr.	eastern hemlock
Plantaginaceae	*Plantago maritima var. juncoides* (Lam.) Gray	goose tongue
Plumbaginaceae	*Limonium carolinianum* (Walt.) Britt.	Carolina sealavender
Poaceae	*Agrostis gigantea* Roth	redtop
	Agrostis hyemalis (Walt.) B.S.P.	winter bentgrass
	Agrostis L.	bentgrass
	Agrostis scabra Willd.	rough bentgrass
	Agrostis stolonifera L.	creeping bentgrass
	Ammophila breviligulata Fern.	American beachgrass
	Anthoxanthum odoratum L.	sweet vernalgrass
	Brachyelytrum septentrionale (Babel) G. Tucker	northern shorthusk
	Calamagrostis canadensis (Michx.) Beauv.	bluejoint
	Danthonia spicata (L.) Beauv. ex Roemer & J.A. Schultes	poverty danthonia
	Deschampsia flexuosa (L.) Trin.	wavy hairgrass
	Dichanthelium (A.S. Hitchc. & Chase) Gould	rosette grass
	Distichlis spicata (L.) Greene	inland saltgrass
	Festuca L.	fescue
	Festuca ovina L.	sheep fescue
	Festuca rubra L.	red fescue
	Glyceria borealis (Nash) Batchelder	northern mannagrass
	Glyceria canadensis (Michx.) Trin.	rattlesnake mannagrass

Family	Scientific Name	Common Name
	Glyceria grandis S. Wats.	American mannagrass
	Glyceria melicaria (Michx.) F.T. Hubbard	melic mannagrass
	Glyceria obtusa (Muhl.) Trin.	Atlantic mannagrass
	Glyceria R. Br.	mannagrass
	Glyceria striata (Lam.) A.S. Hitchc.	fowl mannagrass
	Leersia oryzoides (L.) Sw.	rice cutgrass
	Muhlenbergia glomerata (Willd.) Trin.	spiked muhly
	Muhlenbergia Schreb.	muhly
	Muhlenbergia uniflora (Muhl.) Fern.	bog muhly
	Oryzopsis asperifolia Michx.	roughleaf ricegrass
	Oryzopsis Michx.	ricegrass
	Panicum L.	panicum
	Spartina alterniflora Loisel.	smooth cordgrass
Polygonaceae	*Polygonum achoreum* Blake	leathery knotweed
	Polygonum sagittatum L.	arrowleaf tearthumb
	Rumex orbiculatus Gray	greater water dock
Polypodiaceae	*Polypodium virginianum* L.	rock polypody
	Atrichum P. Beauv.	atrichum moss
	Atrichum undulatum (Hedw.) P. Beauv.	undulate atrichum moss
	Polytrichum commune Hedw.	polytrichum moss
	Polytrichum Hedw.	polytrichum moss
	Polytrichum juniperinum Hedw.	juniper polytrichum moss
	Polytrichum piliferum Hedw.	polytrichum moss
	Polytrichum strictum Brid.	polytrichum moss
Pontederiaceae	*Pontederia cordata* L.	pickerelweed
Potamogetonaceae	*Potamogeton* L.	pondweed
Primulaceae	*Glaux maritima* L.	sea milkwort
	Lysimachia quadrifolia L.	whorled yellow loosestrife
	Lysimachia terrestris (L.) B.S.P.	earth loosestrife
	Trientalis borealis Raf.	American starflower
	Ptilidium Nees	ptilidium
Pyrolaceae	*Orthilia secunda* (L.) House	sidebells wintergreen
	Pyrola americana Sweet	American wintergreen
	Pyrola elliptica Nutt.	waxflower shinleaf
Ranunculaceae	*Anemone virginiana* L.	tall thimbleweed
	Clematis virginiana L.	devil's darning needles
	Coptis trifolia (L.) Salisb.	threeleaf goldthread
	Ranunculus acris L.	tall buttercup
	Ranunculus L.	buttercup
	Thalictrum pubescens Pursh	king of the meadow
Rhamnaceae	*Frangula alnus* P. Mill.	buckthorn
Rhizocarpaceae	*Rhizocarpon geographicum* (L.) DC.	world map lichen
Rosaceae	*Amelanchier arborea* (Michx. f.) Fern.	common serviceberry
	Amelanchier canadensis (L.) Medik.	Canadian serviceberry
	Amelanchier laevis Wieg.	Allegheny serviceberry
	Amelanchier Medik.	serviceberry
	Amelanchier stolonifera Wieg.	running serviceberry

Family	Scientific Name	Common Name
	Aronia melanocarpa (Michx.) Ell.	black chokeberry
	Comarum palustre L.	purple marshlocks
	Dalibarda repens L.	robin runaway
	Fragaria virginiana Duchesne	Virginia strawberry
	Physocarpus opulifolius (L.) Maxim.	common ninebark
	Potentilla simplex Michx.	common cinquefoil
	Prunus pensylvanica L. f.	pin cherry
	Prunus virginiana L.	common chokecherry
	Rosa carolina L.	Carolina rose
	Rosa L.	rose
	Rosa nitida Willd.	shining rose
	Rosa rugosa Thunb.	rugosa rose
	Rosa virginiana P. Mill.	Virginia rose
	Rubus allegheniensis Porter	Allegheny blackberry
	Rubus flagellaris Willd.	northern dewberry
	Rubus hispidus L.	bristly dewberry
	Rubus idaeus L.	American red raspberry
	Rubus L.	blackberry
	Rubus pubescens Raf.	dwarf red blackberry
	Sibbaldiopsis tridentata (Ait.) Rydb.	shrubby fivefingers
	Sorbus americana Marsh.	American mountainash
	Spiraea alba Du Roi	white meadowsweet
	Spiraea tomentosa L.	steeplebush
Rubiaceae	*Galium asprellum* Michx.	rough bedstraw
	Galium L.	bedstraw
	Galium labradoricum (Wieg.) Wieg.	northern bog bedstraw
	Mitchella repens L.	partridgeberry
Salicaceae	*Populus grandidentata* Michx.	bigtooth aspen
	Populus tremuloides Michx.	quaking aspen
	Salix L.	willow
	Salix sericea Marsh.	silky willow
Sarraceniaceae	*Sarracenia purpurea* L.	purple pitcherplant
Scapaniaceae	*Scapania* (Dum.) Dum.	scapania
Scrophulariaceae	*Euphrasia randii* B.L. Robins.	small eyebright
	Melampyrum lineare Desr.	narrowleaf cowwheat
	Veronica officinalis L.	common gypsyweed
Sparganiaceae	*Sparganium americanum* Nutt.	American burreed
	Sparganium L.	burreed
Sphagnaceae	*Sphagnum angustifolium* (C. Jens. ex Russ.) C. Jens. in Tolf	sphagnum
	Sphagnum capillifolium (Ehrh.) Hedw.	sphagnum
	Sphagnum compactum DC. in Lam. & DC.	low sphagnum
	Sphagnum cuspidatum Ehrh. ex Hoffm.	toothed sphagnum
	Sphagnum fimbriatum Wils. in Wils. & Hook. f. in Hook. f.	sphagnum
	Sphagnum flavicomans (Card.) Warnst.	sphagnum
	Sphagnum fuscum (Schimp.) Klinggr.	sphagnum
	Sphagnum girgensohnii Russ.	Girgensohn's sphagnum
	Sphagnum L.	sphagnum

Family	Scientific Name	Common Name
	Sphagnum magellanicum Brid.	Magellan's sphagnum
	Sphagnum majus (Russ.) C. Jens.	sphagnum
	Sphagnum palustre L.	prairie sphagnum
	Sphagnum papillosum Lindb.	papillose sphagnum
	Sphagnum pylaesii Brid.	Pylaes' sphagnum
	Sphagnum recurvum P. Beauv.	recurved sphagnum
	Sphagnum rubellum Wils.	sphagnum
	Sphagnum russowii Warnst.	Russow's sphagnum
	Sphagnum squarrosum Crome	sphagnum
	Sphagnum subsecundum Nees in Sturm	sphagnum
	Sphagnum tenellum (Brid.) Bory	sphagnum
	Sphagnum wulfianum Girg.	Wulf's sphagnum
Thelypteridaceae	*Phegopteris connectilis* (Michx.) Watt	long beechfern
	Thelypteris noveboracensis (L.) Nieuwl.	New York fern
	Thelypteris palustris Schott	eastern marsh fern
Thuidiaceae	*Thuidium delicatulum* (Hedw.) Schimp. in B.S.G.	delicate thuidium moss
Umbilicariaceae	*Umbilicaria* Hoffm.	navel lichen
Violaceae	*Viola cucullata* Ait.	marsh blue violet
	Viola L.	violet
Xyridaceae	*Xyris difformis* Chapman	bog yelloweyed grass

Appendix I

Vegetation Community Descriptions of Acadia National Park

As a result of this vegetation mapping project, we identified 53 vegetation community types (associations) of the National Vegetation Classification System (NVCS) at Acadia National Park (NP). Essential for recognizing floristic vegetation types (association and alliance levels of the NVCS), detailed vegetation descriptions are derived to "provide specific information on the geographical distribution, level of acceptable physiognomic and compositional variation, and the key ecological processes and environmental/abiotic factors that are associated with a type" (Grossman et al.1998). For mapping projects within the USGS-NPS Vegetation Mapping Program, vegetation descriptions not only supply the global (regional) information of vegetation communities, but also local information that deals directly with the plant characterization typical of the national park unit.

With the following pages, we provide vegetation descriptions for each vegetation community identified at Acadia NP with this project. In Appendix B, we provide a dicothomous key to vegetation communities. By using the key in combination with these vegetation descriptions, one can determine the correct vegetation community.

These descriptions are a combination of information from exisiting community descriptions from NatureServe and Maine Natural Areas Program, and from newly acquired and analyzed vegetation sample data from this vegetation mapping project. Because some vegetation community types are based on limited samples, there may be some variations in vegetation characteristizations not captured by this project.

List of Vegetation Community Types (NVCS Associations)

Organized by NVCS structure.

Mapping the NVCS Vegetation Community Classification

Our mapping of natural/semi-natural vegetation is based on NVCS associations (vegetation communities) identified at Acadia NP as a result of this project. Table I-1 on the following pages show the relationships between vegetation communities and the map classification used with the mapping.

To view the relationships in a matrix table format, see Appendix E: Vegetation Classication Matrix. To understand more fully how vegetation communities are mapped, see Appendix F: Map Class Descriptions and Visual Guide.

Table I-1. NVCS vegetation communities (associations) with linkage to map classes.

NVCS Vegetation Community Name (NatureServe Association)	NVCS Synonym Community Name (NatureServe Association)	NatureServe CEGL Code	NVCS Code	Vegetation Map Classes (Map Class Code - Map Class Name)
Note: not all vegetation communities and map classes have a 1:1 relationship.				
Pinus strobus - Tsuga canadensis - Picea rubens Forest	Eastern Hemlock - White Pine - Red Spruce	CEGL006324	I.A.8.N.b.13	WPC - White Pine - Mixed Conifer Forest
Pinus strobus - Pinus resinosa / Cornus canadensis Forest	Red Pine - White Pine Forest	CEGL006253	I.A.8.N.b.14	WRP - Red Pine - White Pine Forest
Picea rubens - Picea glauca Forest	Maritime Spruce - Fir Forest	CEGL006151	I.A.8.N.c.15	SF - Spruce - Fir Forest (conifer phase)
Acer saccharum - Betula alleghaniensis - Fagus grandifolia / Viburnum lantanoides Forest	Northern Hardwood Forest	CEGL006252	I.B.2.N.a.4	MDF - Beech - Birch - Maple Forest
Quercus rubra - Acer rubrum - Betula spp. - *Pinus strobus* Forest	Successional Oak - Pine Forest	CEGL006506	I.B.2.N.a.39	OPF - Oak - Pine Forest WPM - White Pine - Hardwood Forest ROW - Red Oak Woodland
Acer rubrum - Fraxinus spp. / *Nemopanthus mucronatus - Vaccinium corymbosum* Forest	Northern Hardwood Seepage Swamp	CEGL006220	I.B.2.N.e.1	MAS - Red Maple - Hardwood Swamp
Picea rubens - Betula alleghaniensis / Dryopteris campyloptera Forest	Red Spruce - Hardwoods Forest	CEGL006267	I.C.3.N.a.4	SFM - Spruce - Fir Forest (mixed phase)
Picea rubens - Abies balsamea - Betula spp. - *Acer rubrum* Forest	Successional Spruce - Fir Forest	CEGL006505	I.C.3.N.a.4	SFM - Spruce - Fir Forest (mixed phase)
Pinus strobus - Quercus (rubra, velutina) - Fagus grandifolia Forest	White Pine - Oak Forest	CEGL006293	I.C.3.N.a.21	OPF - Oak - Pine Forest
Tsuga canadensis - (Betula alleghaniensis) - Picea rubens / Cornus canadensis Forest	Hemlock - Hardwood Forest	CEGL006129	I.C.3.N.a.32	WPC - White Pine - Mixed Conifer Forest WPM - White Pine - Hardwood Forest
Acer saccharum - Pinus strobus / Acer pensylvanicum Forest	Sugar Maple - White Pine Forest	CEGL005005	I.C.3.N.a.300	OPF - Oak - Pine Forest WPM - White Pine - Hardwood Forest
Picea rubens - Acer rubrum / Nemopanthus mucronatus Forest	Red Maple - Conifer Acidic Swamp	CEGL006198	I.C.3.N.d.10	CSW - Conifer Swamp Woodland (spruce-mixed phase)
Pinus banksiana / Kalmia angustifolia - Vaccinium spp. Woodland	Jack Pine Heath Barren	CEGL006041	II.A.4.N.a.9	JPW - Jack Pine Woodland
Pinus rigida / Vaccinium spp. - *Gaylussacia baccata* Woodland	Pitch Pine / Blueberry spp. - Huckleberry Woodland	CEGL005046	II.A.4.N.a.26	PPB - Pitch Pine - Heath Barren
Pinus rigida / Photinia melanocarpa / Deschampsia flexuosa - Schizachyrium scoparium Woodland	Pitch Pine Rocky Summit	CEGL006116	II.A.4.N.a.26	PPW - Pitch Pine Woodland
Pinus rigida / Corema conradii Woodland	Coastal Pitch Pine Outcrop Woodland	CEGL006154	II.A.4.N.a.26	PPC - Pitch Pine - Corema Woodland
Thuja occidentalis / Gaylussacia baccata - Vaccinium angustifolium Woodland	White-cedar Woodland	CEGL006411	II.A.4.N.b.1	WCW - White Cedar Woodland

NVCS Vegetation Community Name (NatureServe Association)	NVCS Synonym Community Name (NatureServe Association)	NatureServe CEGL Code	NVCS Code	Vegetation Map Classes (Map Class Code - Map Class Name)
Thuja occidentalis - Fraxinus pennsylvanica / Acer pensylvanicum Woodland	Cedar Seepage Slope	CEGL006508	II.A.4.N.b.1	MCW - Mixed Conifer Woodland WCW - White Cedar Woodland
Picea rubens / Vaccinium angustifolium - Sibbaldiopsis tridentata Woodland	Spruce - Fir Rocky Summit	CEGL006053	II.A.4.N.b.3	MCW - Mixed Conifer Woodland MW - Mixed Conifer - Deciduous Woodland
Picea rubens / Ribes glandulosum Woodland	Red Spruce Talus Slope Woodland	CEGL006250	II.A.4.N.b.3	MCW - Mixed Conifer Woodland
Picea mariana / Kalmia angustifolia Woodland	Black Spruce / Heath Rocky Woodland	CEGL006292	II.A.4.N.b.400	MCW - Mixed Conifer Woodland
Thuja occidentalis - Abies balsamea / Ledum groenlandicum / Carex trisperma Woodland	Northern White-cedar Wooded Fen	CEGL006507	II.A.4.N.f.11	WCS - Conifer Swamp Woodland (white cedar phase)
Picea mariana / (Vaccinium corymbosum, Gaylussacia baccata) / Sphagnum sp. Woodland	Black Spruce Woodland Bog	CEGL006098	II.A.4.N.f.13	CSW - Conifer Swamp Woodland (spruce-mixed phase) WCS - Conifer Swamp Woodland (white cedar phase)
Populus (tremuloides, grandidentata) - Betula (populifolia, papyrifera) Woodland	Early Successional Woodland/Forest	CEGL006303	II.B.2.N.a.10	ABF - Aspen - Birch Woodland/Forest Complex (forest phase) ABW - Aspen - Birch Woodland/Forest Complex (woodland phase) ABS - Aspen - Birch Woodland/Forest Complex (shrubland phase) MW - Mixed Conifer - Deciduous Woodland
Quercus rubra - (Quercus prinus) / Vaccinium spp. / *Deschampsia flexuosa* Woodland	Central Appalachian High-Elevation Red Oak Woodland, Northern Variant	CEGL006134	II.B.2.N.a.24	OPF - Oak - Pine Forest ROW - Red Oak Woodland
Betula alleghaniensis - Quercus rubra / Polypodium virginianum Woodland	Red Oak Talus Slope Woodland	CEGL006320	II.B.2.N.a.24	ABW - Aspen - Birch Woodland/Forest Complex (woodland phase)
Acer rubrum / Alnus incana - Ilex verticillata / Osmunda regalis Woodland	Red Maple Swamp Woodland	CEGL006395	II.B.2.N.e.1	MAS - Red Maple - Hardwood Swamp
Alnus incana - Cornus sericea / Clematis virginiana Shrubland	Alluvial Alder Thicket	CEGL006062	III.B.2.N.d.9	ASP - Alder Shrubland
Alnus incana ssp. *rugosa - Nemopanthus mucronatus / Sphagnum* spp. Shrubland	Northern Peatland Shrub Swamp	CEGL006158	III.B.2.N.e.9	ASP - Alder Shrubland FX - Fen Complex
Myrica gale - Spiraea alba - Chamaedaphne calyculata Shrubland	Sweetgale Mixed Shrub Swamp	CEGL006512	III.B.2.N.g.9	SG - Sweetgale Mixed Shrub Fen FX - Fen Complex
Morella pensylvanica - Empetrum nigrum Dwarf-shrubland	Crowberry - Bayberry Maritime Shrubland	CEGL006510	IV.A.1.N.b.7	CB - Crowberry - Bayberry Headland
Kalmia angustifolia - Chamaedaphne calyculata - (Picea mariana) / Cladina spp. Dwarf-shrubland	Northern Dwarf-shrub Bog	CEGL006225	IV.A.1.N.g.1	DSB - Dwarf Shrub Bog FX - Fen Complex

NVCS Vegetation Community Name (NatureServe Association)	NVCS Synonym Community Name (NatureServe Association)	NatureServe CEGL Code	NVCS Code	Vegetation Map Classes (Map Class Code - Map Class Name)
Chamaedaphne calyculata / Eriophorum virginicum / Sphagnum rubellum Dwarf-shrubland	Leatherleaf Acidic Fen	CEGL006513	IV.A.1.N.g.1	FX - Fen Complex
Empetrum nigrum - Gaylussacia dumosa - Rubus chamaemorus / Sphagnum spp. Dwarf-shrubland	Maritime Crowberry Bog	CEGL006248	IV.A.1.N.g.4	FX - Fen Complex
Vaccinium angustifolium - Sorbus americana / Sibbaldiopsis tridentata Dwarf-shrubland	Blueberry Granite Barrens	CEGL005094	IV.B.2.N.a.1	BBSS - Blueberry Bald - Summit Shrubland Complex
Ammophila breviligulata - Lathyrus japonicus Herbaceous Vegetation	Northern Beachgrass Dune	CEGL006274	V.A.5.N.c.2	AM - Dune Grassland
(Pinus strobus, Quercus rubra) / Danthonia spicata Acid Bedrock Wooded Herbaceous Vegetation	White Pine - Oak Acid Bedrock Glade	CEGL005101	V.A.5.N.e.8	OPF - Oak - Pine Forest MW - Mixed Conifer - Deciduous Woodland
Trichophorum caespitosum - Gaylussacia dumosa / Sphagnum (fuscum, rubellum, magellanicum) Herbaceous Vegetation	Maritime Peatland Sedge Lawn	CEGL006260	V.A.5.N.h.1	DSB - Dwarf Shrub Bog
Carex stricta - Carex vesicaria Seasonally Flooded Herbaceous Vegetation	Eastern Tussock Sedge Meadow	CEGL006412	V.A.5.N.k.36	FX - Fen ComplexSMG - Graminoid Shallow Marsh
Calamagrostis canadensis - Scirpus spp. - *Dulichium arundinaceum* Herbaceous Vegetation	Seasonally Flooded Mixed Graminoid Meadow	CEGL006519	V.A.5.N.k.39	FX - Fen Complex SMG - Graminoid Shallow Marsh
Eriocaulon aquaticum - Lobelia dortmanna Herbaceous Vegetation	Seven-angle Pipewort - Dortmann's Cardinal-flower Herbaceous Vegetation	CEGL006346	V.A.5.N.l.2	OWM - Open Water - Deep Marsh Complex
Juncus militaris Herbaceous Vegetation	Bayonet Rush Herbaceous Vegetation	CEGL006345	V.A.5.N.l.3	SMG - Graminoid Shallow Marsh
Typha (angustifolia, latifolia) - (Schoenoplectus spp.*)* Eastern Herbaceous Vegetation	Eastern Cattail Marsh	CEGL006153	V.A.5.N.l.9	SMG - Graminoid Shallow Marsh OWM - Open Water - Deep Marsh Complex
Schoenoplectus (tabernaemontani, acutus) Eastern Herbaceous Vegetation	Bulrush Deepwater Marsh	CEGL006275	V.A.5.N.l.16	OWM - Open Water - Deep Marsh Complex
Carex (lasiocarpa, utriculata, canescens) Herbaceous Vegetation	Slender Sedge Fen	CEGL006521	V.A.5.N.m.7	FX - Fen Complex SMG - Graminoid Shallow Marsh
Typha angustifolia - Hibiscus moscheutos Herbaceous Vegetation	Brackish Tidal Marsh, Cattail Variant	CEGL004201	V.A.5.N.n.2	TG - Tidal Marsh
Spartina patens - Distichlis spicata - (Juncus gerardii) Herbaceous Vegetation	Spartina High Salt Marsh	CEGL006006	V.A.5.N.n.11	TG - Tidal Marsh
Carex (oligosperma, exilis) - Chamaedaphne calyculata Shrub Herbaceous Vegetation	Few-seeded Sedge - Leatherleaf Fen	CEGL006524	V.A.7.N.o.3	FX - Fen Complex
Vallisneria americana - Potamogeton perfoliatus Herbaceous Vegetation	Open Water Marsh with Mixed Submergents/Emergents	CEGL006196	V.C.2.N.a.17	OWM - Open Water - Deep Marsh Complex
Nuphar lutea ssp. *advena - Nymphaea odorata* Herbaceous Vegetation	Water Lily Aquatic Wetland	CEGL002386	V.C.2.N.a.102	OWM - Open Water - Deep Marsh Complex

NVCS Vegetation Community Name (NatureServe Association)	NVCS Synonym Community Name (NatureServe Association)	NatureServe CEGL Code	NVCS Code	Vegetation Map Classes (Map Class Code - Map Class Name)
Polypodium (virginianum, appalachianum) / Lichen spp. Nonvascular Vegetation	Northern Lichen Talus Barrens	CEGL006534	VI.B.1.N.c.300	SVT - Sparsely Vegetated Talus
Solidago sempervirens - (Rhodiola rosea) - Juniperus horizontalis Sparse Vegetation	Northern Maritime Rocky Headlands	CEGL006529	VII.A.2.N.a.4	SVH - Open Headland - Beach Strand
Cakile edentula ssp. *edentula - Mertensia maritima* Sparse Vegetation	Sea-rocket - Oysterleaf Sparse Vegetation	CEGL006106	VII.C.2.N.a.2	SVH - Open Headland - Beach Strand